Digital Health:

After the COVID Boom

JUNE | 2023

Digital Health

After the COVID Boom

Authors
Citlalli Blanchet
Alice Bluestone
Craig Cartossa, ASA, MAAA
Jim Dolstad, ASA, MAAA, FCA
Caixia Ge, FSA, MAAA
Blake Harris, ASA, MAAA
Gordon D. Kaplan, PhD
Mike Lizonitz, FSA
Mario Suarez
David Tuomala, FSA, FCA, MAAA

Sponsors
Society of Actuaries Research Institute Health Care Cost Trends Strategic Research Program

CONTENTS

Digital Health

After the COVID Boom

Executive Summary

INTRODUCTION

The COVID-19 pandemic initially caused some health care services to shift away from in-person transactions to a digital form, including telehealth, e-mails, remote patient monitoring and other forms of communication. If sustained, numerous effects and counter-effects both in the cost and quality of care as well as long-term outcomes for patient health may emerge.

RESEARCH APPROACH

The researchers for this paper are all employed by Optum, a subsidiary of UnitedHealth Group, or UnitedHealth Group. Optum is a leading health solution and care delivery organization serving both providers and payers. To gain an understanding of COVID-19's impact on digital health and the health system in general, this paper includes both literature review and several actuarial analyses using data available to Optum. While the definition of "digital health" can be very broad, for the purpose of this research on digital health, our actuarial analysis focuses on telehealth, and the literature review will include telehealth and some remote patient monitoring.

The literature review we conducted for this paper included scanning over 2,007 articles as potential references for this paper. Ultimately, we summarized 177 articles for inclusion within this paper. Details and key findings from the literature review are detailed in Section 1. For ease of understanding, the findings are synthesized into the quintuple aim: improved patient experience, improved patient health, reduced cost of care, improved provider experience and improved health equity. In addition, a wealth of telehealth reference articles is provided in the references.

To perform the analytics, we needed to develop a structure regarding the coding and changes in coding as COVID-19 progressed. This paper lays out a framework that researchers can use as a guide to develop their own analyses in the future. The quantitative analysis explored an important actuarial question that we did not see directly addressed in the literature: For a Medicare Advantage population, was there a decrease in coding of the U.S. Department of Health and Human Services' Hierarchical Condition Categories risk factors for members that used telehealth? The case study in this paper shows a slight increase — not decrease — in risks coded, although there are numerous confounding factors.

For the purpose of this study, we define pre COVID-19 as the time period prior to March 2020, the peak COVID-19 as March 2020 to June 2022, and post peak COVID-19 as July 2022 forward.

INSIGHTS

The data and actuarial analysis directionally validate much of the literature review on changes in digital health utilization before, during and post peak COVID-19. Given that we used different data sources for this paper, there are naturally differences in magnitude by area, line of business and time based on a wide range of factors including COVID-19 prevalence rates and local protocols.

Common themes we saw in both the literature review and analysis of claims experience are:

1. Use of telehealth was low but consistently increasing prior to COVID-19.
2. Providers and patients quickly adapted to telehealth to address restrictions during the Peak COVID-19.
3. Overall telehealth utilization has dropped off post-peak COVID-19 but remains higher than pre COVID-19 utilization.
4. Medicare use of telehealth for mental health and substance abuse has remained near the average of peak COVID-19 levels (March 2020 through July 2022).
5. Research and best practices are emerging as to how best to deploy telehealth, for what purposes and what conditions, but more work needs to be done.
6. The impact of telehealth on the short- and long-term cost reduction has promise, but much more analysis of health outcomes is required before any conclusions can be reached.

Throughout this paper, we call out numerous telehealth successes that directionally point toward increasing utilization and potentially lower cost of care. While access to care has improved, patient and provider experience is mixed as process flows, provider compensation and optimization of telehealth are refined. Our analysis shows that the adoption rate of telehealth varies by geography, with the North Central region having the highest adoption rate. Future analysis may want to focus on understanding geographical variations. Broadband and smartphone availability as well as digital literacy are barriers to telehealth for some members of disadvantaged populations that need to be addressed.

LIMITATIONS AND FUTURE RESEARCH

We wrote this paper as the nation is coming out of COVID-19 as a public health emergency and returning to the new normal. It will be interesting to see how telehealth utilization changes and health outcomes are impacted in future research as more data becomes available. Favorable policies and provider reimbursement changes facilitated the use of telehealth services during the peak COVID-19. Post peak COVID-19, patient and provider preferences and quality considerations will become more important in assessing the outlook for telehealth services. Changes in reimbursement and other policies as the peak of COVID-19 ends will also become important. The impact of those items on future utilization remains unknown and will need to be addressed with future research.

As we wrote this report, the Biden administration announced that the public health emergency associated with the COVID-19 pandemic ended in May 2023. Whether that will result in changes to payment and other policies related to telehealth remains to be seen. It is likely that future time periods will see further changes for telehealth in the post-emergency environment. As new data becomes available, the methodology we provide in this paper will enable providers and payers to consistently track key metrics related to telehealth to lead to a better understanding of its impact on health outcomes and total cost of care.

Section 1: Literature Research

This section analyzes the evolution of telehealth purely from the research perspective. The section is based on identifying some of the most relevant articles out of the nearly 13,000 articles published to date. To help provide structure to the wealth of information in the articles reviewed, we selected the quintuple aim to make the information most easily consumable. The first part of this section covers the research approach and definitions used. The second part of this section highlights the findings of our research leveraging the quintuple aim. Finally, we summarized the future of telehealth integration based on the research we reviewed. This literature review summarizes what we know so far about telehealth and what factors are likely to affect the future growth of telehealth.

For readers highly interested in literature research, we recommend you read this section and Appendix 2, along with all the references. For those wanting to understand what research we reviewed and the key findings, the following two subsections may meet your needs.

1.1. RESEARCH APPROACH

SELECTION OF ARTICLES AND DEFINITIONS

The concept of telehealth has existed since the early 20th century. Since 2000, the health care system had been increasing its use of digitally supported health care delivery, also known as remote patient monitoring (RPM). However, only recently have both telehealth and RPM seen rapid growth in implementation and integration into the health care system. That growth has been accompanied by an exponential increase in research publications. For example, a PubMed search using the terms “telehealth” and telemedicine” in the title finds 12,912 articles dating back to 1974, with 65% occurring since 2017. Similarly, a search using “remote patient monitoring” shows a similar trend with 579 articles dating back to 1986 but with 75% occurring since 2017. Appendix 1 provides graphics by decade.

The immediate cause of that exponential growth has been the recent COVID-19 pandemic. An overwhelmed health care system faced catastrophic challenges as it had to address federal and state stay-at-home mandates while protecting both patients’ and providers’ health. The health care industry scrambled to meet those challenges by increasing the use of telehealth modalities. After two years of this national “experiment” in health care delivery, the industry and regulators are now beginning to understand will need to address issues for telehealth to reach its full potential to fulfill its promise for improving health care.

It is important to define the terms we use in this report and discuss the necessary limitations in the scope of this review. “Digital health” is defined as: “Digital health, or digital healthcare, is a broad, multidisciplinary concept that includes concepts from an intersection between technology and healthcare. Digital health applies digital transformation to the healthcare field, incorporating software, hardware and services. Under its umbrella, digital health includes mobile health (mHealth) apps, electronic health records (EHRs), electronic medical records (EMRs), wearable devices, telehealth and telemedicine, as well as personalized medicine” (Bernstein 2023).

Our focus in this review, however, is on the health care delivery modalities of telehealth and telemedicine. A variety of definitions have been offered for “telehealth” and “telemedicine,” which are terms that are often used interchangeably (Tuckson et al. 2017). We will follow that approach and use the broader term “telehealth” as the focus of this review.

The breadth of what constitutes telehealth is captured in the World Health Organization (WHO) definition for telemedicine: “… the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of diseases and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities" (Mileski et al. 2017).

With that broad definition, nearly every aspect of the system delivering non-face-to-face health care (not just medical care that physicians deliver) to individuals would be included. In addition, all forms of communication of health information (telephonic, video or electronic) and among health care professionals and between health care providers and their patients would also be included. Therefore, it is necessary to apply some restrictions. In this review, we define the term "telehealth" similarly to Lee and Hughes (2017): Telehealth is the use of modern technology in smartphones or computers and potentially augmented by medical monitoring devices by health care professionals to provide health care services to their patients without them needing to leave home or office. As such, telehealth will always involve a two-way communication between the health care provider and patient, although the communication may be synchronous as in an audio/video visit, or it may be asynchronous involving messaging email/text between the provider and patient.

As the above definition demonstrates, telehealth is not monolithic. It can take many forms depending on providers' capabilities and patients' needs and abilities. Although it is possible to study different components of telehealth, it is more helpful to ask how telehealth should be applied by the health care industry in providing health care to patients within the varying contexts that arise (Sundhar, K.R. 2021). Barring data to the contrary, all forms of telehealth should be supported.

FRAMEWORK FOR LITERATURE REVIEW

A high-quality health care system is one that provides the populations it serves with the right care via the right provider at the right time and in the right place. An effective health care system is one where healthcare payers', providers' and patients' perspectives converge and are the overarching goal. Those goals have evolved over the years. Initially stated as a "Triple Aim for Healthcare" (Berwick et al. 2008), the goals were then expanded to a quadruple set of aims for health care (Arnetz et al. 2020). Stated briefly, these aims are:

1. Improved patient experience marked by improved access to, easy navigation within and helpful interactions with the health care system.
2. Improved patient health outcomes marked by improved physical and mental well-being.
3. Decreased healthcare costs marked by the affordability of health care and decreased preventable or unnecessary health care spending.
4. Improved provider well-being marked by a system that supports providers' ability to operate at the peak of their training and that diminishes conditions leading to provider burnout.

More recently, a fifth aim has been suggested, and we predict it will be rapidly adopted:

- Health equity marked by equal access to health care across all population groups.

The last aim has been proposed because, as Nundy et al. (2022) point out, health equity is an outcome that is not necessarily guaranteed even if the other four aims are being addressed.

Both payers and providers generally endorse the quintuple aim. Telehealth has the potential to address all five for health care (Goldberg et al. 2022). It has already been proposed that telehealth be judged on its ability to deliver across these aims (Bearnes et al. 2021).

1.2. KEY OBSERVATIONS

- Telehealth utilization was on the rise pre COVID-19 and peaked during March 2020 to June 2022.
- Utilization post peak COVID-19 decreased but remains above pre COVID-19 levels.
- Necessary to conduct research to understand where to optimize telehealth.
- Provider infrastructure needs improvement as do best practices for “webside” manner.
- Potential exists to improve health outcomes and address disparities.

As highlighted in the Executive Summary, this paper incorporates a robust literature review in Appendix 3 and the references. This section provides a high-level review with the key observations noted in the takeaway box. The health care industry has often analyzed initiatives based on the triple aim, which over time has grown to the quintuple aim. Because that framework has become an industry standard, this section also summarizes the literature review into that structure.

Telehealth adoption and utilization was on the rise prior to the COVID-19 pandemic. Its use was based on and continues to be driven by rapidly improving device and communications technologies within the private sector. Its growth was being limited by infrastructure issues around patient and provider access and experience, reimbursement policies, physician/health system investment in infrastructure, and physician incentive structures. The COVID-19 pandemic forced all of that to change nearly overnight. Reimbursement issues were addressed; providers had no choice but to adapt and learn how to use telehealth to provide effective care for most patient visits. But the improved ability to prevent and manage COVID-19 has now resulted in a decline in telehealth utilization, although current levels are still well above pre-pandemic levels. That decline was to be expected and is not necessarily a bad thing. There needs to be time for research to document the conditions under which telehealth produces comparable or superior results to in-person care. Such data will or should guide future access and reimbursement policies. As the healthcare industry moves into a new model for more integrated, patient-centric health care delivery, providers, patients and policies will drive the rate of telehealth utilization. Ultimately, the value of telehealth will need to be based on sound research that demonstrates its ability to promote population health improvement. Those results will almost definitely be population- and condition-specific, which suggests that efforts to expand telehealth utilization should be directed toward such populations.

On the patient end, educating patients on how to interact effectively with providers using telehealth is a top priority. Access to telehealth is another shortcoming to be addressed by the industry, regulators, and those providing broadband access to assure such populations have the technology and access to use telehealth effectively. On the provider end, continued refinement of infrastructure including workflows and technology is needed. Providers also need guidance and training on how to use telehealth within the practice of their specialty. Telehealth can provide a way for providers to stay more connected to those patients who need them the most. Ongoing training in webside manner is necessary to prevent online/smartphone interactions from becoming less personal than is the case for in-person interactions. Finally, on the policy end, decision-makers must establish policies that promote equitable availability and reimbursement of telehealth services that follow established guidelines.

There is not enough research outside of pandemic conditions to reach firm conclusions about how best to integrate telehealth into health care going forward. However, available research is promising. Telehealth for the most part is delivering on most of the aims agreed upon as important for developing an effective and equitable health care system. It provides a better experience for patients, which patients confirmed via their ratings of their telehealth experience during the pandemic. It contributes to improved health outcomes, particularly in situations where a breakdown in patient/provider connection would have the most negative impact on health. It can create a better experience for providers, which is also seen in their ratings of telehealth during the pandemic. It can contribute to lower health care costs primarily through its ability to improve health and reduce preventable health care utilization.

It is only in the last aim of health equity where significant improvement in access to telehealth across disparate groups, access to "like" providers delivering telehealth, and education, if telehealth is to realize its promise. Taken together, this suggests that actuaries can be cautiously optimistic as they define telehealth value.

Summary of Telehealth's Impact on Quintuple Aims	
Improved patient experience	Patient access improved as the industry adapted to COVID-19. However, opportunities remain to optimize infrastructure and services
Improved patient health	This was directionally positive across many conditions, but further research is required to determine what services telehealth can best deliver, like behavioral health.
Reduced cost of care	Short- and long-term cost reduction opportunities are generally favorable across many conditions and needs. However, more work needs to be done to understand the long-term implications on improvement in a patient's health to strengthen any assertions.
Improved provider experience	There were mixed reviews for, neutral and against. Provider compensation for telehealth visits will be a determining factor in providers' future acceptance in addition to best practices regarding patient flow, particularly for providers at risk.
Improved health equity	Studies before and during the pandemic showed exacerbation of disparities in some instances and no exacerbation in other instances. Access to broadband and smartphones as well as digital literacy are key barriers that are known and being addressed.

Section 2: Quantitative Analysis and Findings

The previous section reviewed a broad cross-section of literature to understand the market's perspective on telehealth's utilization, adaptation, value and future. This section leverages data to address many of those same questions. We provide data sources and methodology so readers can perform similar analyses to test whether they are seeing similar or different results with their own data sets.

The health care industry rapidly and continually adapted its services to the onset and nuances of COVID-19, which has had a tremendous impact on the health care industry. The industry developed new protocols for in-office and in-patient visits, created new lab tests, added new diagnosis codes and modifiers, and shut down certain services. From an actuarial perspective, COVID-19 dramatically disrupted utilization and the actuarial models that were dependent on that data. The Centers for Medicare and Medicaid Services (CMS) added new codes, as well as modifiers, in the early stages of COVID-19, which caused additional challenges in accurately pulling together consistent views in any time over time analysis.

Before getting into the observations, it is important to understand the data we used, and code sets we applied to derive the observations. Below is a summary of the data sources and coding logic used.

2.1. DATA SOURCE AND METHODOLOGY

The overall data set is based on Optum Benchmarking Data with national multipayer de-identified claims and enrollment data with over 20 million commercial and Medicare members. Refer to Appendix 4 for more details.

TIME PERIOD

Member data is for Jan. 1, 2019, to Dec. 31, 2021; claims data was incurred Jan. 1, 2019, to Dec. 31, 2021, and paid through June 30, 2022.

CLAIMS CODING LOGIC

Because the data covers multiple years, this study uses the 2021 effective code list and crosswalks old procedure codes to an equivalent 2021 code. To identify telehealth services, Optum applied the logic by provider specialty, revenue code, place of service code, procedure code and procedure modifier. Appendix 5 lists the codes Optum utilized.

We also validated claims against the CMS list of telehealth-eligible procedure codes and filtered the data set to only include physician claims (e.g., exclude facility claims) and only those codes that are CMS eligible. We further limited the data set to only include home, office and telehealth as the place of service. Appendix 6 shows the CMS-eligible telehealth codes and assigned procedure categories.

2.2. TELEHEALTH UTILIZATION

Using Optum historical claims data, Optum summarized the utilization rate for telehealth services by major service category, age group and region and compared that against nontelehealth services. See figures 1 and 2 below.

The utilization rate is defined as number of visits per 1,000 members per time period (e.g., month, quarter or year). It is calculated by dividing overall visits for each grouping/category by the total number of members for the same time and multiplying the result by 1,000. We first transformed the service line level claim data into visit level by defining a visit as the unique combination of member, provider and date of service. Because visits may include multiple services, we used a hierarchical ranking to assign each visit to a single procedure category. We then rolled up visit data to the claim group level based on place of service, procedure/service category and provider type. Please see Appendix 7 for the detailed code list.

Please note that for claims/visits with multiple services, the procedure category and claim group were assigned based on the highest ranking (aka lowest value) from the mapping table.

- Example 1: A claim from a mental health and substance abuse (MHSA) provider, occurring in the home, with two procedure codes, one from CMS-EM and one from CMS-MHSA, would be rolled up and categorized as CMS-MHSA because CMS-MHSA has the higher priority (100 vs 101).
- Example 2: A visit with procedure category CMS-MHSA occurring in the office with an MHSA provider would be assigned to claim group MHSA (ranking 108).

Key Findings on Telehealth Utilization

- Same as literature review findings, our benchmarking data shows telehealth utilization for evaluation and management (E&M) services was on the rise preCOVID-19 and peaked in March 2020 as well as in December 2020 (second peak). Utilization decreased following the two peak seasons but remains above the pre COVID-19 level.
- Telehealth accounts for a small fraction of total utilization, even at the peak of COVID-19.
- MHSA telehealth increased a lot more than E&M services and stayed high following the two peak seasons. The absolute increases for both E&M and MHSA are about the same.
- Telehealth utilization varies by age group. For the commercial population, age group 30-39 uses the most telehealth services as proportional to overall total services. We did not observe any significant differences in different Medicare age groups.
- For different utilization patterns among different regions, NorthCentral has the highest telehealth utilization for the commercial population. The Medicare population does not show significant differences by region.

Figures 1 and 2 below summarize the utilization rate by various groupings, separately commercial and Medicare populations.

Figure 1
COMMERCIAL TELEHEALTH UTILIZATION BY PROCEDURE CATEGORY

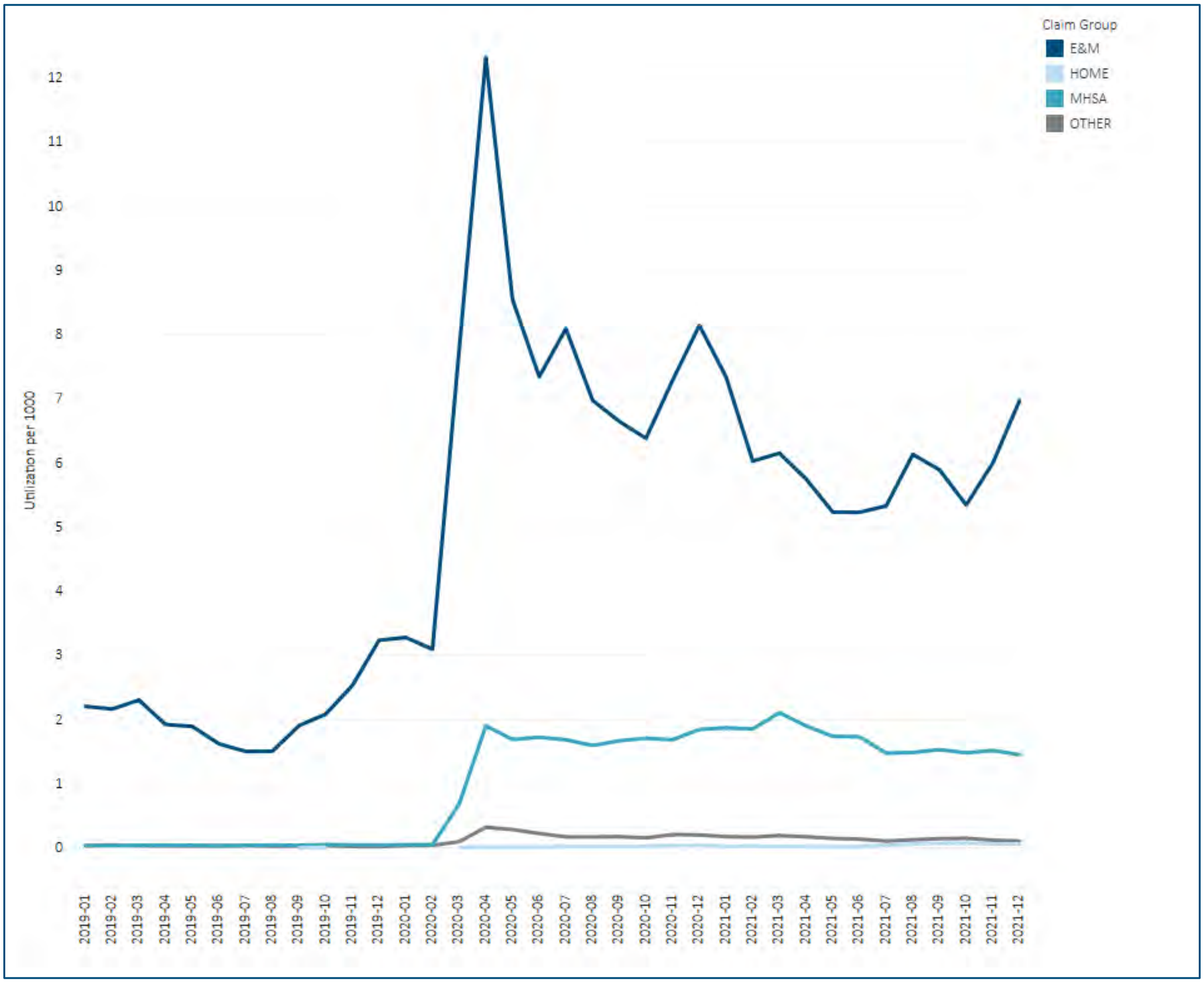
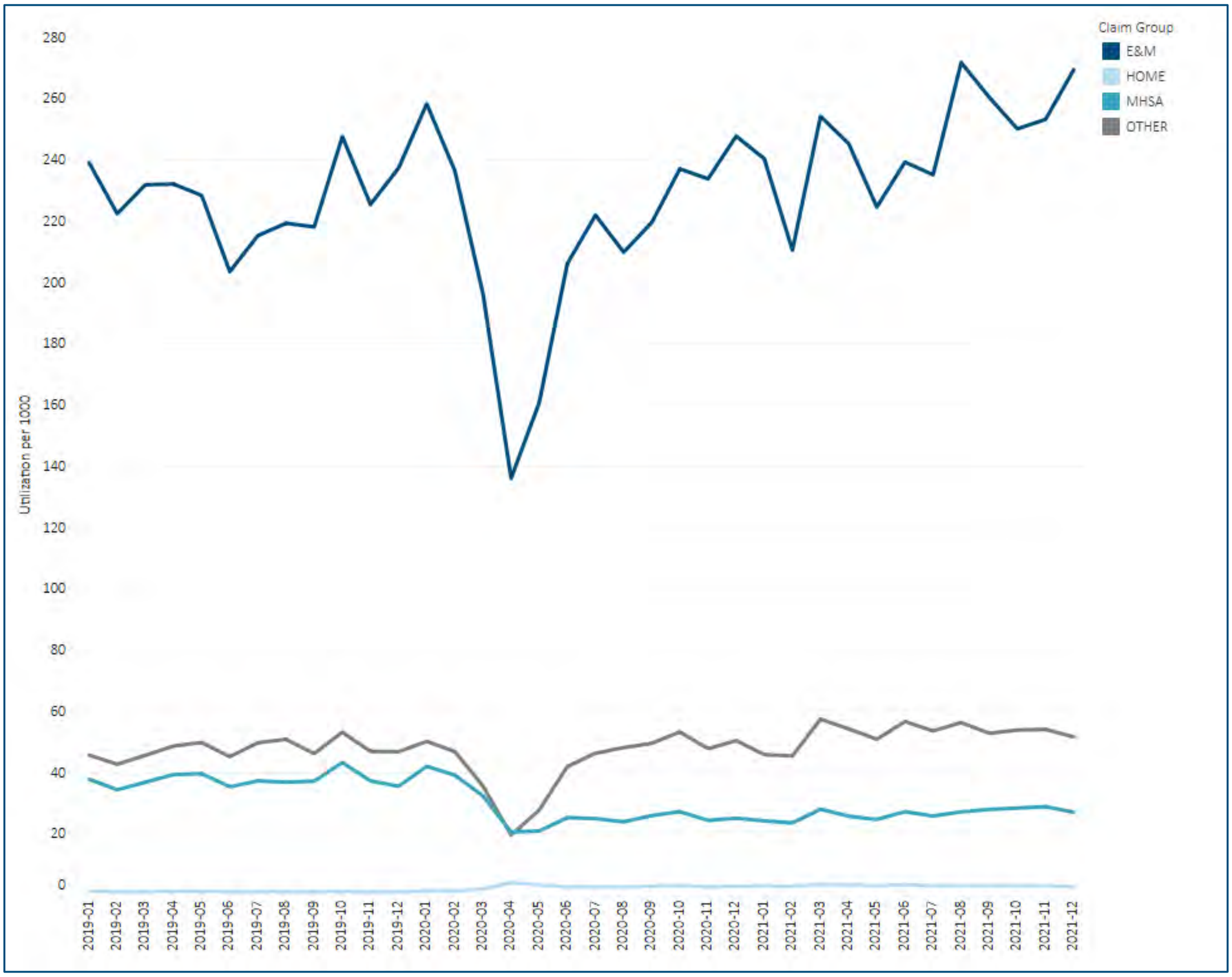


Figure 2

COMMERCIAL NONTELEHEALTH UTILIZATION BY PROCEDURE CATEGORY



Once COVID-19 hit in 2020 and the United States government established state and federal policies, telehealth utilization naturally increased significantly. We observed the sharpest jump from February to April 2020. MHSA in April 2020 was 47.5 times the utilization in February 2020, and E&M was 4.0 times. Comparing the months of April through December in 2021 to the same months in 2020, there was a decrease in the E&M category and the MHSA category. However, the utilization decreased at a slower rate for MHSA than for E&M.

Utilization for nontelehealth showed a significant decrease in April 2020. MHSA for nontelehealth has not returned to the utilization levels observed before April 2020. For the rest of the service categories studied, there was an increase in nontelehealth utilization compared to the levels observed prior April 2020.

As stated in AIM5, literature review, "the greatest challenge for telehealth remains the ability of healthcare systems to deliver it equitably across populations traditionally at risk for health disparities. These include patient demographics such as race (non-white), socioeconomic status (lower income; homeless), geographic region (rural/remote), and age (elderly)" (Cantor et al. 2021; Katz et al. 2022; Uscher-Pines 2022; Cao et al. 2021; Drake et al. 2022; Jewett et al. 2022; Qian et al. 2022). To analyze that, we also reviewed at the utilization rate by different age group and region. See tables 1 and 2 for age group summary and Figure 3 for region summary.

Table 1 summarizes the proportion of telehealth utilization to the total utilization by age group by quarter. As expected, the second quarter of 2020 shows the highest proportion of telehealth utilization. Tables 2 and 3 summarize the utilization rate per 1,000 members for telehealth service alone in total as well as the share of telehealth services as a percentage of total services.

Table 1

COMMERCIAL TELEHEALTH UTILIZATION BY AGE GROUP

Age Group	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
00-19	0.8%	3.4%	1.9%	1.8%	1.6%	1.3%	1.2%	1.2%
20-29	2.2%	6.1%	4.2%	3.8%	3.5%	3.3%	3.1%	3.3%
30-39	2.7%	6.7%	4.6%	4.1%	4.0%	3.7%	3.6%	3.7%
40-49	1.9%	5.0%	3.2%	3.0%	2.9%	2.5%	2.4%	2.6%
50-64	1.1%	4.1%	2.2%	2.2%	2.1%	1.6%	1.5%	1.6%
Total for all ages	**1.6%**	**4.9%**	**3.0%**	**2.8%**	**2.7%**	**2.2%**	**2.1%**	**2.2%**

Table 2

COMMERCIAL TELEHEALTH UTILIZATION BY AGE GROUP – MHSA SERVICES

Telehealth Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
00-19	0.72	5.35	4.36	4.83	5.27	4.52	3.17	3.23
20-29	1.00	6.74	6.64	7.17	8.05	7.59	6.62	6.56
30-39	0.93	6.39	6.38	6.72	7.60	7.36	6.47	6.38
40-49	0.70	4.97	4.81	4.93	5.53	5.14	4.45	4.37
50-64	0.51	3.55	3.24	3.25	3.56	3.21	2.76	2.70
Total for all ages	**0.75**	**5.27**	**4.90**	**5.19**	**5.77**	**5.32**	**4.44**	**4.40**

Total Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
00-19	115.37	63.01	72.64	81.49	86.31	91.42	90.01	99.60
20-29	140.40	92.78	106.69	107.88	107.28	106.82	111.55	112.65
30-39	134.42	88.48	95.33	95.38	91.21	89.91	94.96	96.24
40-49	113.98	74.09	79.26	79.24	77.42	78.33	81.23	83.43
50-64	80.53	53.42	57.59	56.49	55.30	56.31	58.72	58.83
Total for all ages	**114.34**	**72.03**	**79.76**	**81.93**	**81.59**	**82.96**	**85.41**	**88.72**

Telehealth Share	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
00-19	0.6%	8.5%	6.0%	5.9%	6.1%	4.9%	3.5%	3.2%
20-29	0.7%	7.3%	6.2%	6.6%	7.5%	7.1%	5.9%	5.8%
30-39	0.7%	7.2%	6.7%	7.0%	8.3%	8.2%	6.8%	6.6%
40-49	0.6%	6.7%	6.1%	6.2%	7.1%	6.6%	5.5%	5.2%
50-64	0.6%	6.6%	5.6%	5.7%	6.4%	5.7%	4.7%	4.6%
Total for all ages	**0.7%**	**7.3%**	**6.1%**	**6.3%**	**7.1%**	**6.4%**	**5.2%**	**5.0%**

Table 3
COMMERCIAL TELEHEALTH UTILIZATION BY AGE GROUP — E&M SERVICES

Telehealth Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
00-19	6.48	10.19	8.41	8.13	6.79	6.80	8.28	9.02
20-29	14.60	28.69	25.27	24.59	20.08	17.48	18.86	19.53
30-39	22.15	37.85	31.15	30.49	27.57	24.45	26.12	27.02
40-49	17.68	33.72	25.56	25.94	23.83	19.49	20.90	22.21
50-64	13.13	35.68	23.64	25.20	23.01	16.54	16.71	17.99
Total for all ages	**14.13**	**28.23**	**21.72**	**21.81**	**19.52**	**16.21**	**17.35**	**18.32**

Total Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
00-19	648.57	302.90	434.75	492.17	495.93	563.84	648.22	694.72
20-29	504.49	430.28	571.26	642.20	611.82	568.95	619.13	606.43
30-39	618.38	505.91	633.50	711.33	683.36	656.96	718.95	700.97
40-49	743.56	615.86	752.50	822.81	802.63	785.28	835.99	830.74
50-64	940.88	798.71	970.80	1,039.18	1,009.37	1,006.52	1,053.04	1,061.33
Total for all ages	**705.51**	**531.01**	**673.21**	**740.55**	**724.81**	**725.60**	**784.85**	**791.30**

Telehealth Share	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
00-19	1.0%	3.4%	1.9%	1.7%	1.4%	1.2%	1.3%	1.3%
20-29	2.9%	6.7%	4.4%	3.8%	3.3%	3.1%	3.0%	3.2%
30-39	3.6%	7.5%	4.9%	4.3%	4.0%	3.7%	3.6%	3.9%
40-49	2.4%	5.5%	3.4%	3.2%	3.0%	2.5%	2.5%	2.7%
50-64	1.4%	4.5%	2.4%	2.4%	2.3%	1.6%	1.6%	1.7%
Total for all ages	**2.0%**	**5.3%**	**3.2%**	**2.9%**	**2.7%**	**2.2%**	**2.2%**	**2.3%**

Below are our observations:

- Age group 20-29 has the highest MHSA utilization (for both telehealth and overall visits).
- Age group 30-39 has the highest share of telehealth utilization as a percent of total visit.
- E&M utilization has a different behavior than the one for MHSA.
  - The highest telehealth utilization age group is 30-39.
  - The highest overall E&M utilization age group is 50-64.
  - Age group 30-39 has the highest portion of telehealth utilization.

The results are not surprising given that age group 30-39 is mostly tech savvy and a busy working group. For the oldest age group, 50-64, even though the overall E&M services utilization is high, the proportion of telehealth E&M utilization is not as high as the younger age groups.

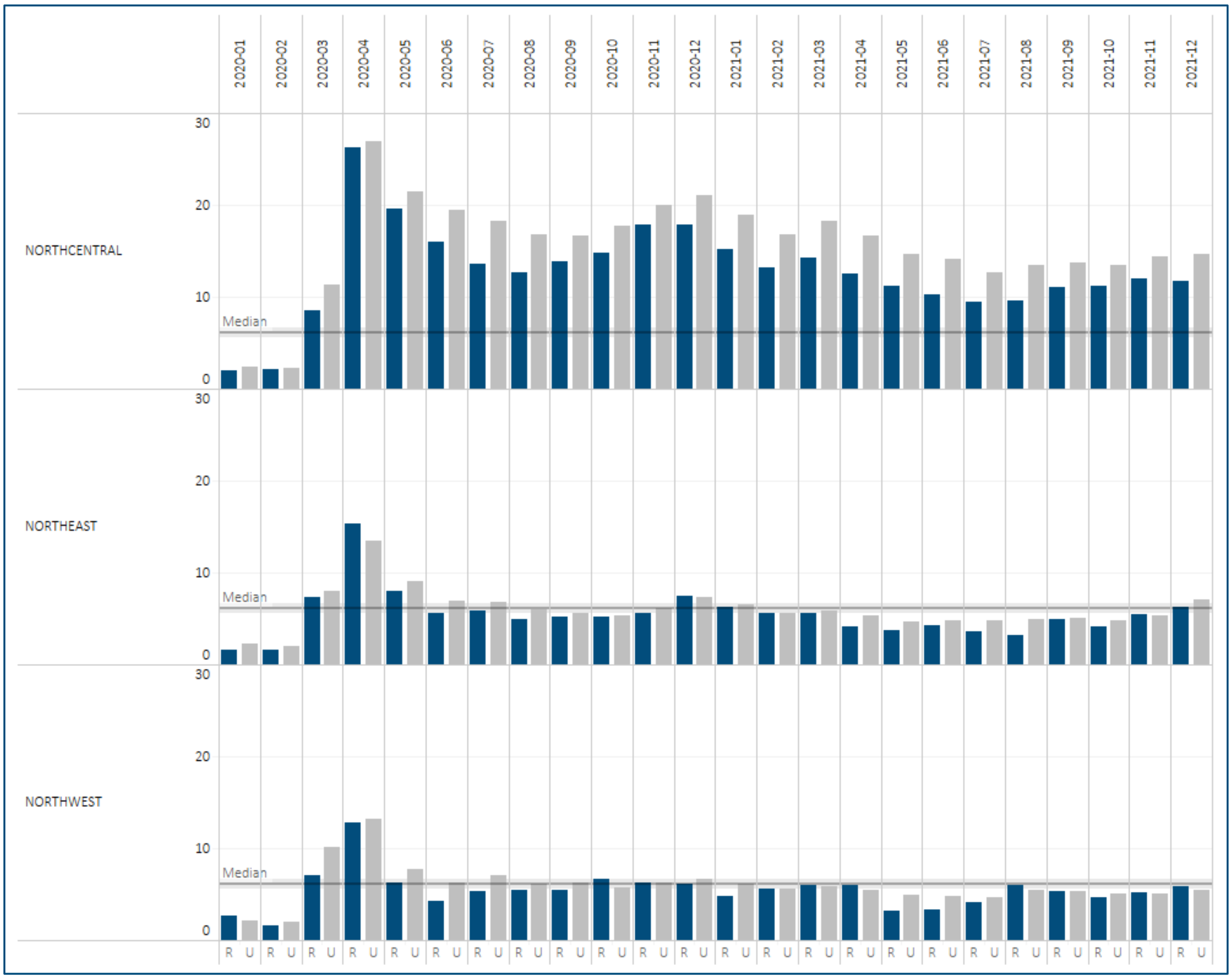
To analyze regional differences in telehealth utilization, we separated the nation into three north regions and three south regions (see below). In addition, we defined rural vs. urban using United States Department of Agriculture Rural-Urban Commuting Area (RUCA) (Cromartie). These codes analyze census tracts based on population density, urbanization and daily commute. Based on those analyses, each census tract is assigned a code from 1 being highly metropolitan to 10 being highly rural, with 6 being micropolitan and 7 being small town. Find RUCA code definitions in Appendix 10.

- North Central: Iowa, Illinois, Indiana, Michigan, Minnesota, North Dakota, Nebraska, South Dakota, Wisconsin.

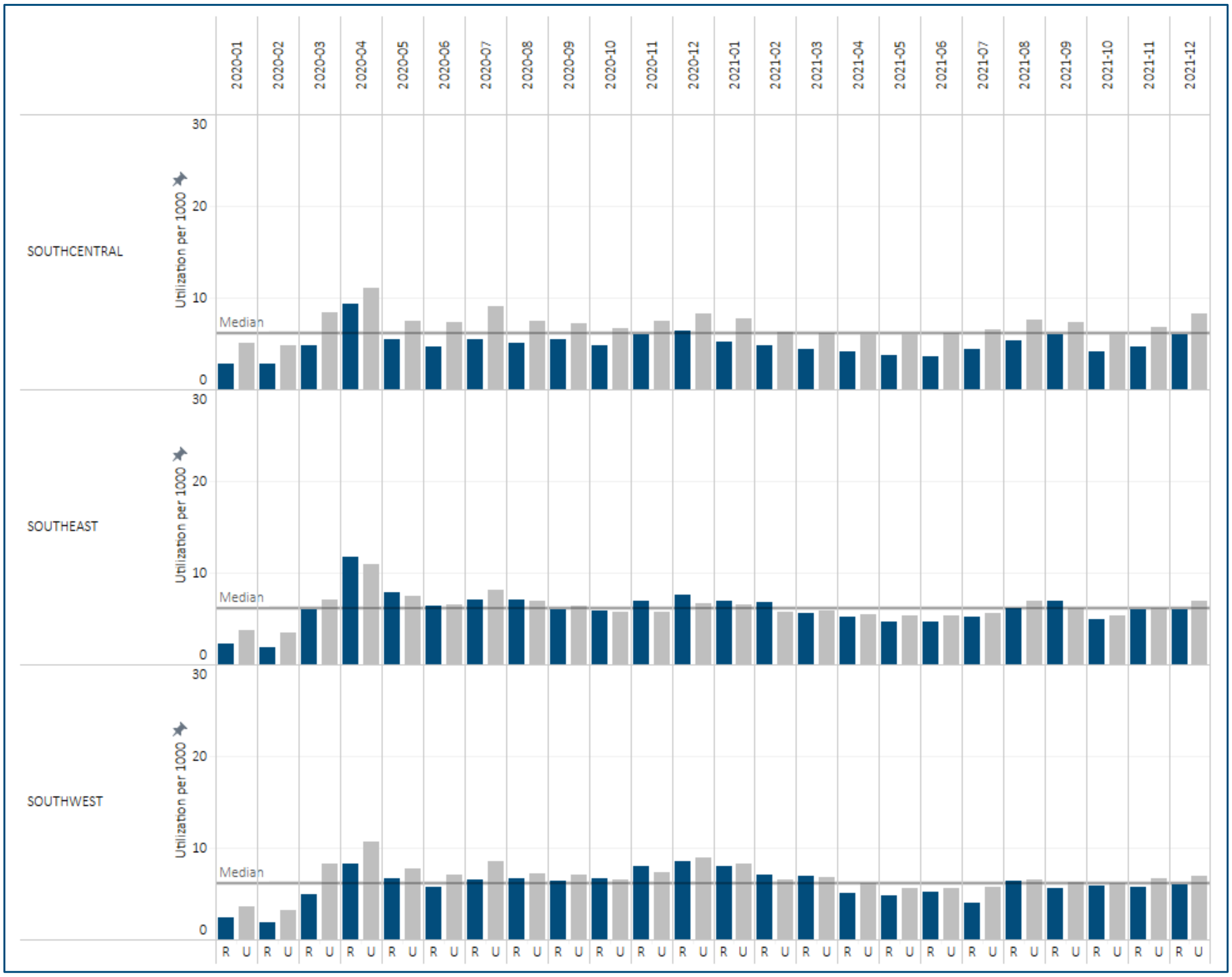
- Northeast: Connecticut; Washington, D.C.; Delaware; Massachusetts; Maryland; Maine; New Hampshire; New Jersey; New York; Ohio; Pennsylvania; Rhode Island; Vermont.
- Northwest: Idaho, Montana, Oregon, Washington, Wyoming.
- Southcentral: Arkansas, Kansa, Missouri, Oklahoma, Texas.
- Southeast: Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia.
- Southwest: Arizona, California, Colorado, New Mexico, Nevada, Utah.

Figure 3

COMMERCIAL TELEHEALTH UTILIZATION BY NORTH REGION AND RURAL VS. URBAN



COMMERCIAL TELEHEALTH UTILIZATION BY SOUTH REGION AND RURAL VS. URBAN

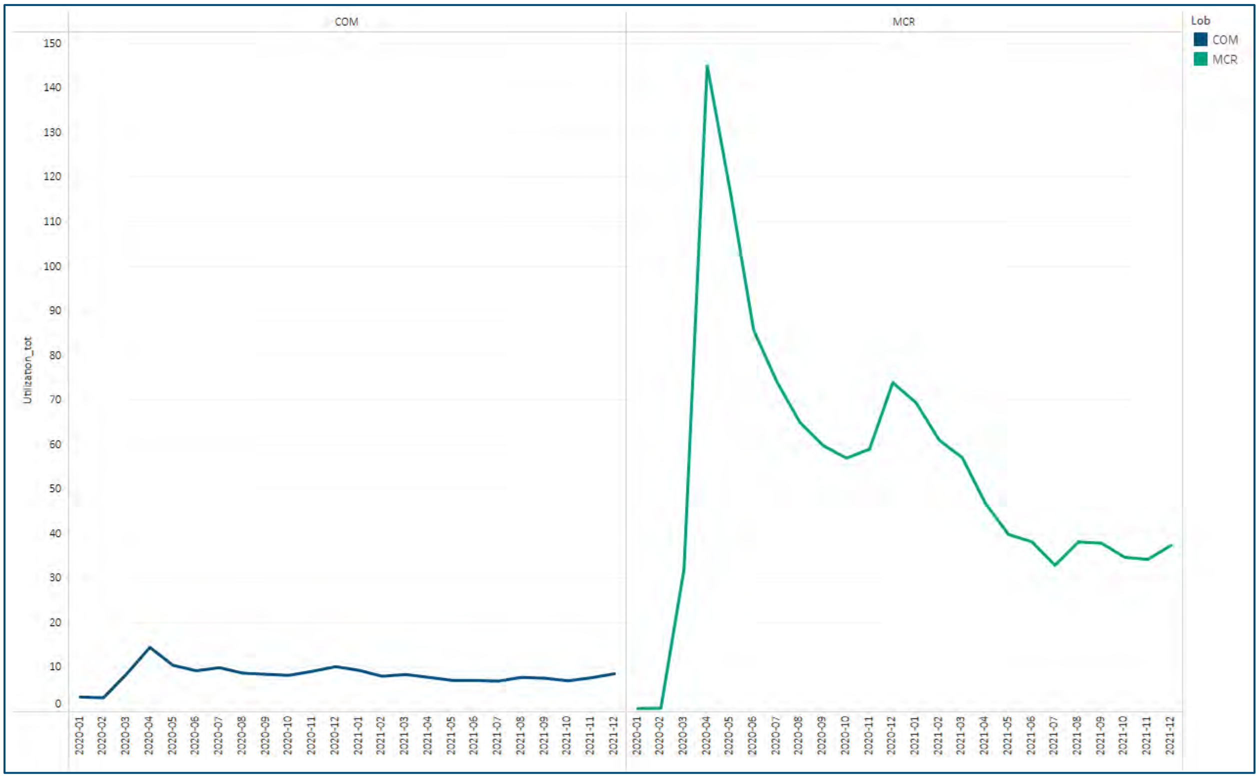


The middle line of each figure represents the national utilization rate median of 6.13. The main finding is that North Central has significantly higher utilization rates compared to other regions. Another consistent pattern is that the urban utilization rates are slightly greater than the rural urbanization rates across most regions and months.

We investigated the high utilization in the North Central region; Minnesota mainly drives it, with North Dakota partially driving it. Minnesota's E&M total utilization looks on par with other states or region with more telehealth utilization. That might be explained by the parity law (Star Tribune). Minnesota is one of the early states to adopt the law. Changes during the pandemic have provided convenient new options for patients. Previously, Minnesota patients may have had to drive to a clinic or hospital to use their telemedicine facilities. Now, they can connect from home using a personal device. Mental health practitioners included also is an advance.

The Medicare population shows similar utilization patterns but in different magnitudes. Figure 4 shows the comparison of overall commercial and Medicare telehealth utilization rates. Both commercial and Medicare show sharp increases in April 2020 and a second peak in December 2020. However, Medicare utilization was 10 times that of commercial utilization in April 2020, and Medicare utilization was five times commercial utilization in October 2021.

Figure 4
COMMERCIAL VS. MEDICARE TELEHEALTH UTILIZATION



The following figures and tables summarize the telehealth vs. nontelehealth utilization for the Medicare population by procedure category, age group and region.

Figure 5

MEDICARE TELEHEALTH UTILIZATION BY PROCEDURE CATEGORY

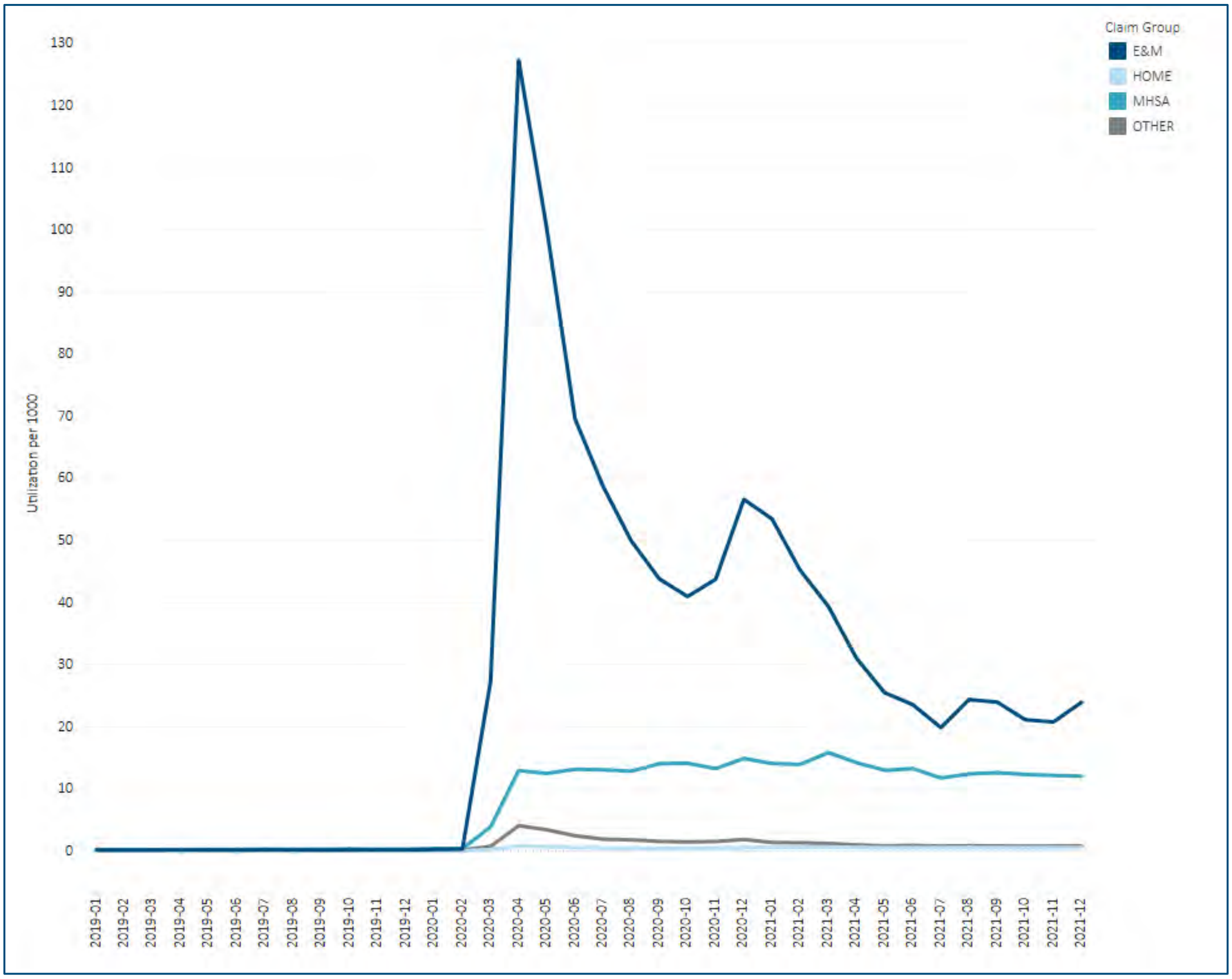
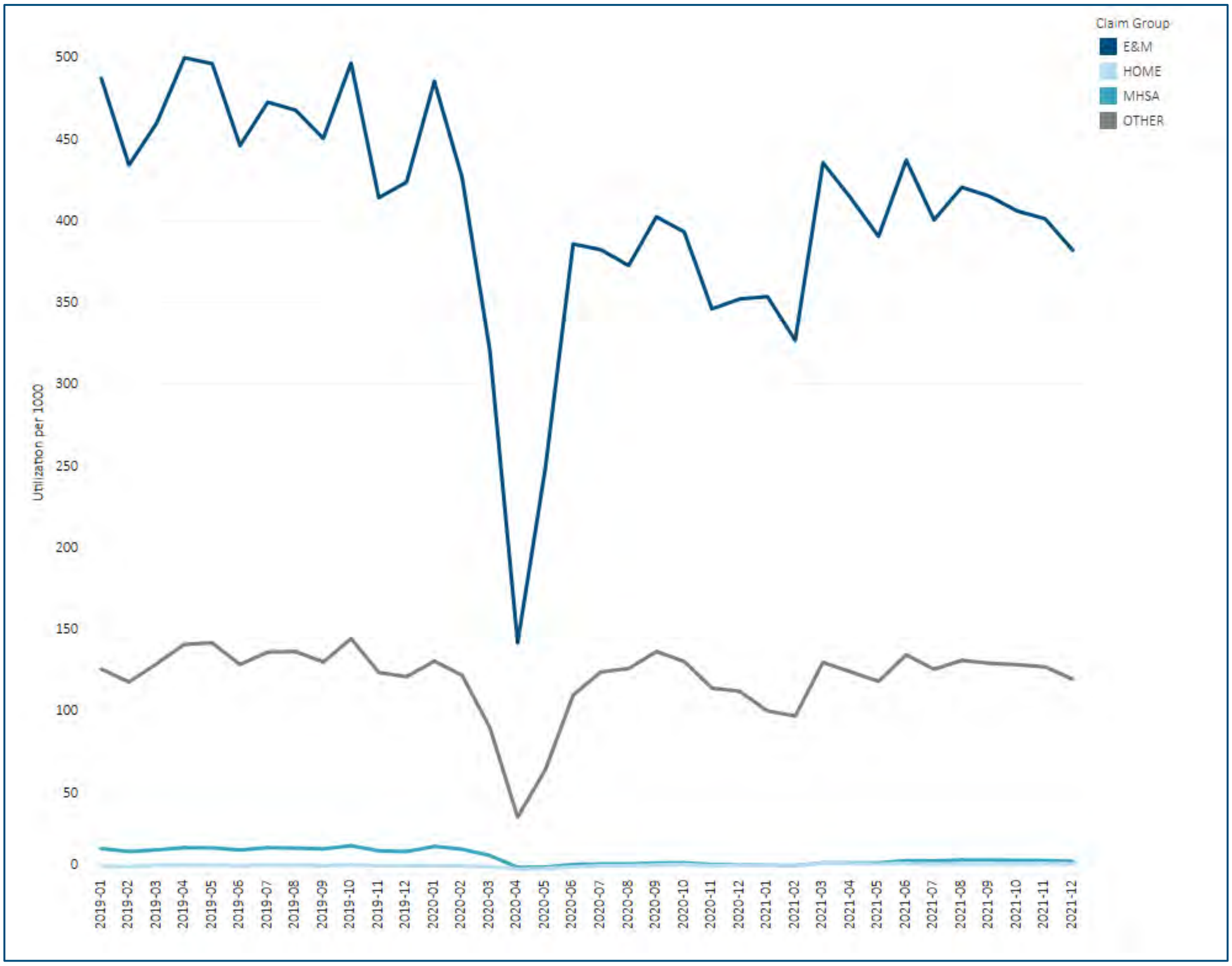


Figure 6
MEDICARE NONTELEHEALTH UTILIZATION BY PROCEDURE CATEGORY



Like the commercial population, telehealth utilization for the Medicare population was significantly higher in 2020 than in 2019. Throughout 2021, the levels of utilization remained higher than those in 2019, but there has been a decrease compared to the levels in 2020 for all the categories analyzed except for mental health. The MHSA utilization for April 2021 is 10% higher than the utilization in April 2020. For physician E&M visits, we see a decrease in utilization where utilization in April 2021 is 0.25 times the utilization in April 2020.

However, there was a significant decrease in utilization for nontelehealth services in April 2020. After April 2020, the levels of utilization for MHSA have been consistently lower than before this date. MHSA utilization for nontelehealth in December 2021 is 56% of that in December 2019. Conversely, as noted above, the telehealth utilization for MHSA for the Medicare population increased in April 2020 and has remained at those levels or slightly higher. For E&M nontelehealth services, utilization levels increased after April 2020 but are still lower than in 2019. For example, utilization in September 2021 is 92.1% of that experienced in September 2019.

Table 4

MEDICARE TELEHEALTH UTILIZATION BY AGE GROUP

Age Group	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
65-69	2.4%	27.2%	12.9%	13.0%	13.3%	8.9%	7.9%	7.9%
70-74	2.1%	25.7%	11.4%	11.6%	11.7%	7.4%	6.5%	6.5%
75-79	1.9%	24.3%	10.3%	10.4%	10.4%	6.2%	5.4%	5.4%
80-84	1.8%	24.0%	9.7%	9.9%	9.7%	5.5%	4.7%	4.7%
85+	1.8%	25.6%	10.4%	10.3%	9.9%	5.5%	4.7%	4.8%
Total for all ages	3.8%	36.3%	22.3%	22.7%	23.4%	18.1%	16.3%	16.7%

Table 5

MEDICARE TELEHEALTH UTILIZATION BY AGE GROUP — MHSA SERVICES

Telehealth Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
65-69	6.39	52.87	53.80	55.68	60.73	55.86	50.55	49.44
70-74	4.88	42.69	44.20	47.28	48.64	45.30	40.83	40.35
75-79	3.97	33.12	34.85	37.15	39.07	35.64	32.30	32.47
80-84	3.13	24.53	26.24	28.09	29.27	25.86	22.93	22.65
85+	2.62	19.77	18.75	18.23	19.01	16.50	14.35	14.21
Total for all ages	3.89	29.93	30.03	30.75	29.84	28.34	25.51	25.66

Total Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
65-69	69.18	73.73	80.56	80.90	85.97	87.25	86.12	83.65
70-74	55.55	59.69	66.78	68.64	68.71	70.07	69.27	67.81
75-79	42.96	46.15	52.55	54.10	55.20	55.69	55.24	54.36
80-84	29.51	33.59	38.71	40.43	40.91	40.48	39.48	38.32
85+	19.35	25.61	26.25	26.19	26.61	25.81	24.61	24.08
Total for all ages	34.31	40.85	44.08	44.26	42.02	43.23	42.32	42.07

Telehealth Share	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
65-69	9.2%	71.7%	66.8%	68.8%	70.6%	64.0%	58.7%	59.1%
70-74	8.8%	71.5%	66.2%	68.9%	70.8%	64.6%	58.9%	59.5%
75-79	9.2%	71.8%	66.3%	68.7%	70.8%	64.0%	58.5%	59.7%
80-84	10.6%	73.0%	67.8%	69.5%	71.6%	63.9%	58.1%	59.1%
85+	13.5%	77.2%	71.5%	69.6%	71.4%	63.9%	58.3%	59.0%
Total for all ages	11.3%	73.3%	68.1%	69.5%	71.0%	65.5%	60.3%	61.0%

Table 6

MEDICARE TELEHEALTH UTILIZATION BY AGE GROUP — E&M SERVICES

Telehealth Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
65-69	26.44	262.16	137.76	129.72	129.64	77.53	66.75	65.33
70-74	27.58	288.72	149.97	140.64	134.83	79.17	68.20	66.05
75-79	29.36	317.52	161.28	149.22	143.45	82.12	69.71	66.88
80-84	29.59	333.33	165.97	153.11	146.24	81.76	69.15	65.16
85+	27.23	322.51	164.19	147.75	145.44	82.49	68.10	65.40
Total for all ages	27.84	296.78	152.28	141.31	137.95	80.03	68.18	65.81

Total Util/k	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
65-69	1,079.07	930.46	1,114.99	1,066.57	1,088.42	1,130.94	1,118.19	1,083.79
70-74	1,222.54	1,046.20	1,285.28	1,225.25	1,206.62	1,273.71	1,270.01	1,235.50
75-79	1,392.40	1,193.36	1,467.99	1,381.41	1,381.23	1,466.34	1,455.82	1,405.41
80-84	1,459.87	1,246.08	1,538.27	1,429.99	1,450.06	1,549.27	1,527.26	1,459.88
85+	1,311.26	1,091.74	1,347.11	1,232.52	1,307.73	1,394.13	1,355.57	1,277.88
Total for all ages	1,259.63	1,073.53	1,309.62	1,232.57	1,253.98	1,321.51	1,304.18	1,254.79

Telehealth Share	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
65-69	2.5%	28.2%	12.4%	12.2%	11.9%	6.9%	6.0%	6.0%
70-74	2.3%	27.6%	11.7%	11.5%	11.2%	6.2%	5.4%	5.3%
75-79	2.1%	26.6%	11.0%	10.8%	10.4%	5.6%	4.8%	4.8%
80-84	2.0%	26.8%	10.8%	10.7%	10.1%	5.3%	4.5%	4.5%
85+	2.1%	29.5%	12.2%	12.0%	11.1%	5.9%	5.0%	5.1%
Total for all ages	2.2%	27.6%	11.6%	11.5%	11.0%	6.1%	5.2%	5.2%

Unlike the commercial population, we did not see significant differences in telehealth utilization by different age groups or region.

Figure 7

MEDICARE TELEHEALTH UTILIZATION BY NORTH REGION AND RURAL VS. URBAN

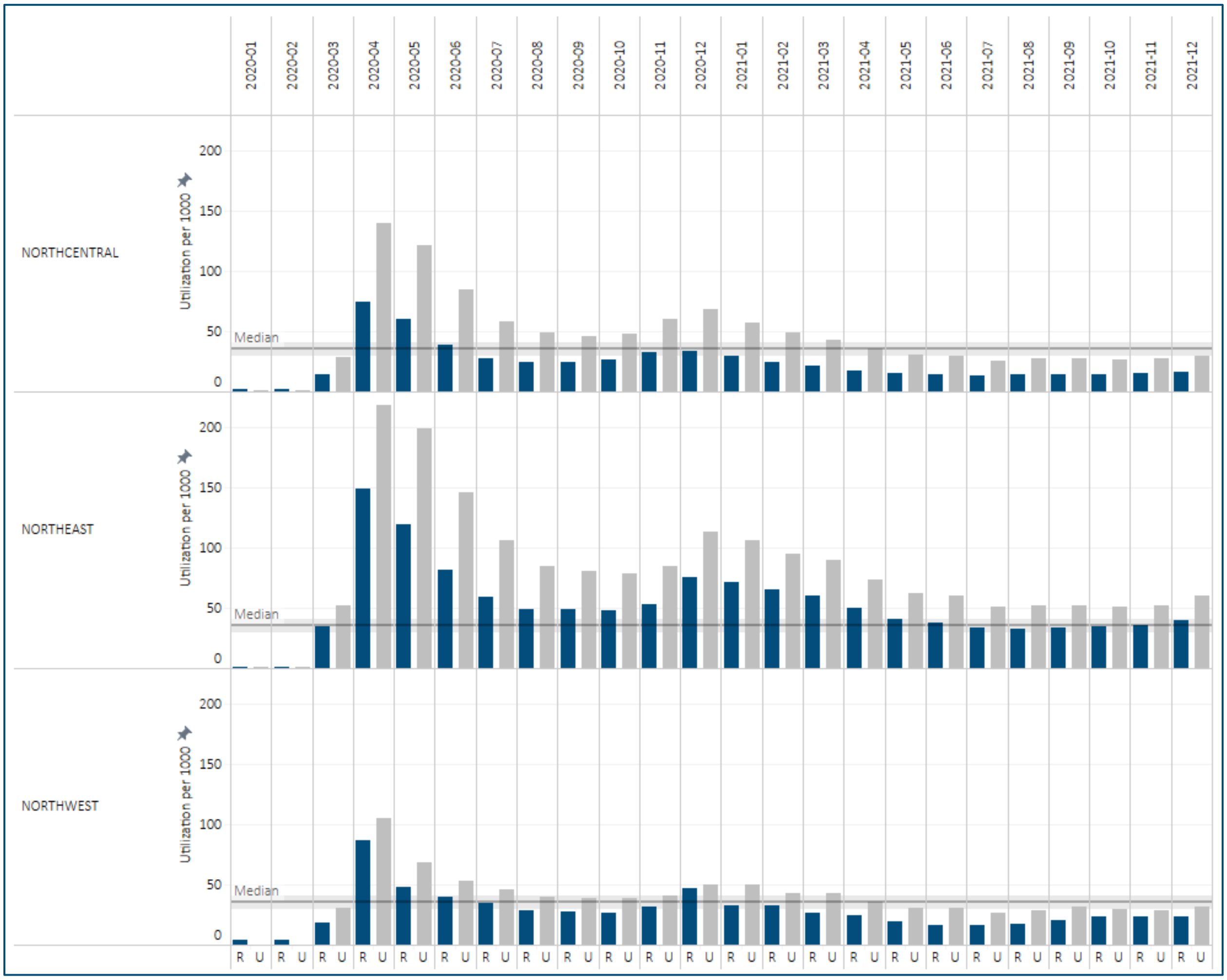
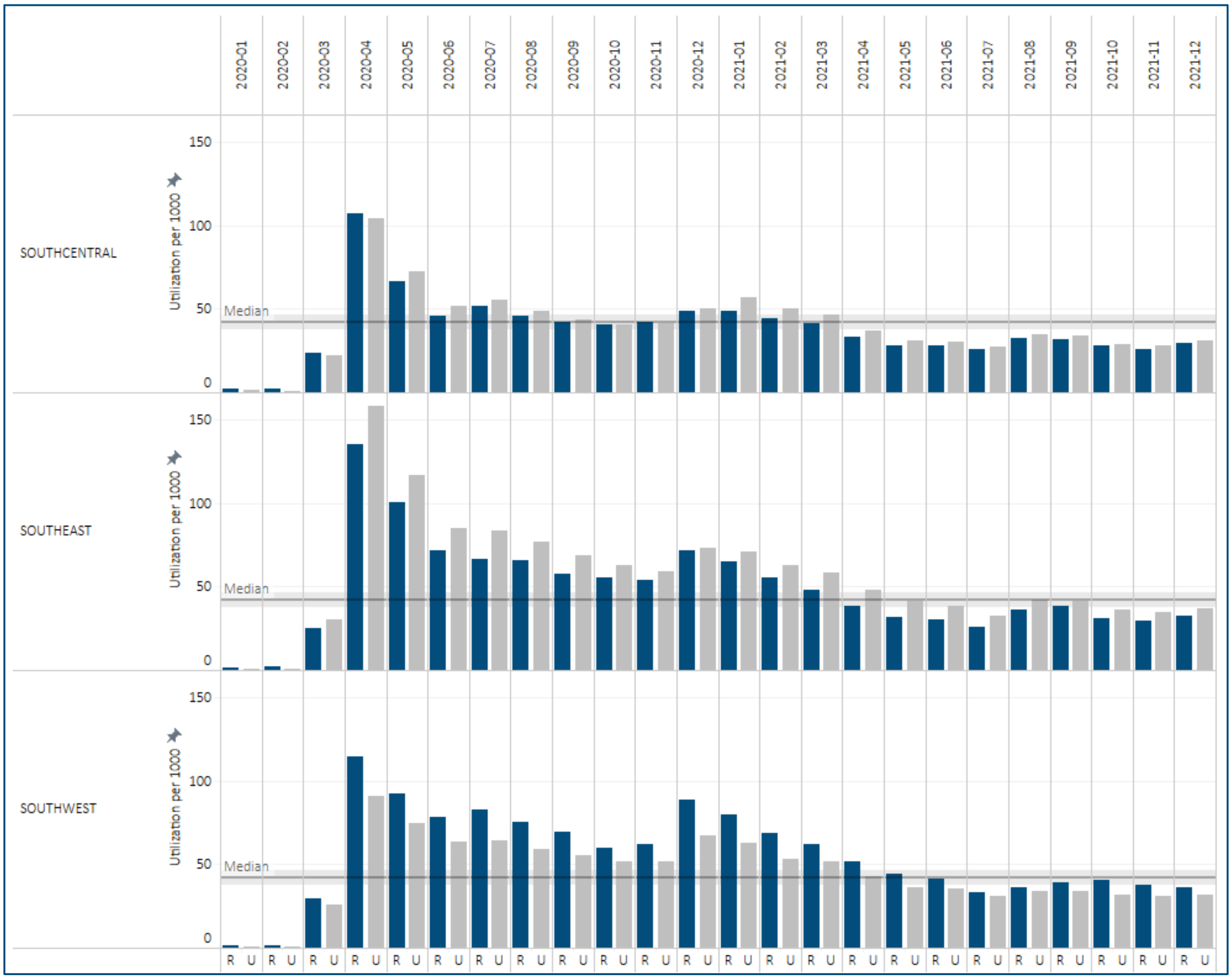


Figure 8

MEDICARE TELEHEALTH UTILIZATION BY SOUTH REGION AND RURAL VS. URBAN



2.3. ADOPTION RATE FOR TELEHEALTH

To further investigate the timing of telehealth adoption and address the question of which consumer populations are most likely to switch to telehealth health, we studied the adoption rate by Line of Business (LOB). Adoption rate is defined as follows in our study, and Figures below summarize the main findings.

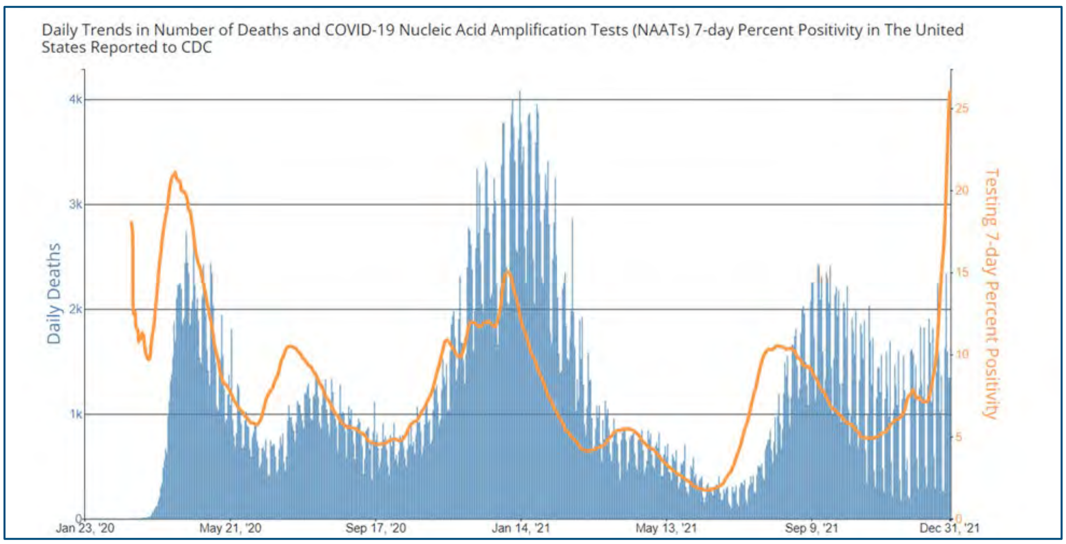
Adoption rate definition: $Adoption\ Rate\ in\ Month(n)=(Count\ of\ Members\ whose\ first\ telehealth\ claim\ was\ in\ month(n\ ))/(Total\ effective\ members\ in\ month\ (n))$

Key Observations

- Comparing the COVID-19 related utilization peaks seen on a national level, we can see that commercial telehealth adoption rate for E&M service follows the same pattern, with peaks during the same time periods. Medicare telehealth adoption rates also have similar peaks.
- Northern regions have higher adoption rates than Southern regions. That is more pronounced in the commercial population than Medicare population.
- In all regions, we saw that the higher levels of telehealth adoption rate coincide with the higher periods of COVID-19 deaths. (Figures 9-14 show those patterns.)
- Toward the end of 2021, the levels of adoption rates were very similar for all the regions.

Figure 9

CDC PUBLICATION



Centers for Disease Control and Prevention. 2022. *Daily trends in Number of Deaths and COVID-19 Nucleic Acid Amplification tests (NAATs) 7-day Percent Positivity in the United States Reported to CDC.* Chart. COVID-19 Tracker. trends_weeklydeaths_7dayeddiagnosed_00.

Figure 10

COMMERCIAL E&M CLAIMS ADOPTION RATE

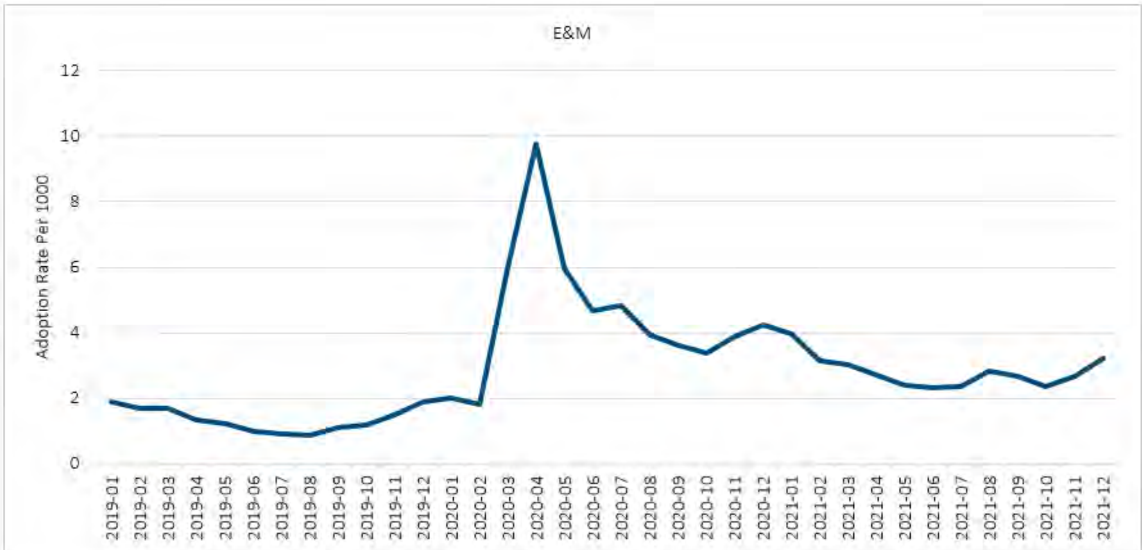


Figure 11

COMMERCIAL ADOPTION RATE BY REGION — NORTH REGIONS

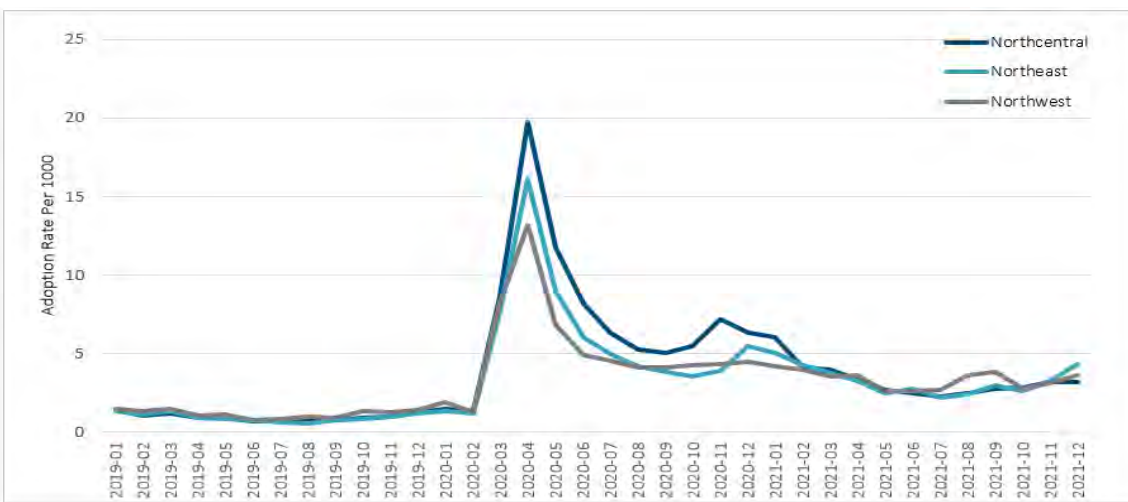


Figure 12

COMMERCIAL ADOPTION RATE BY REGION — SOUTH REGIONS

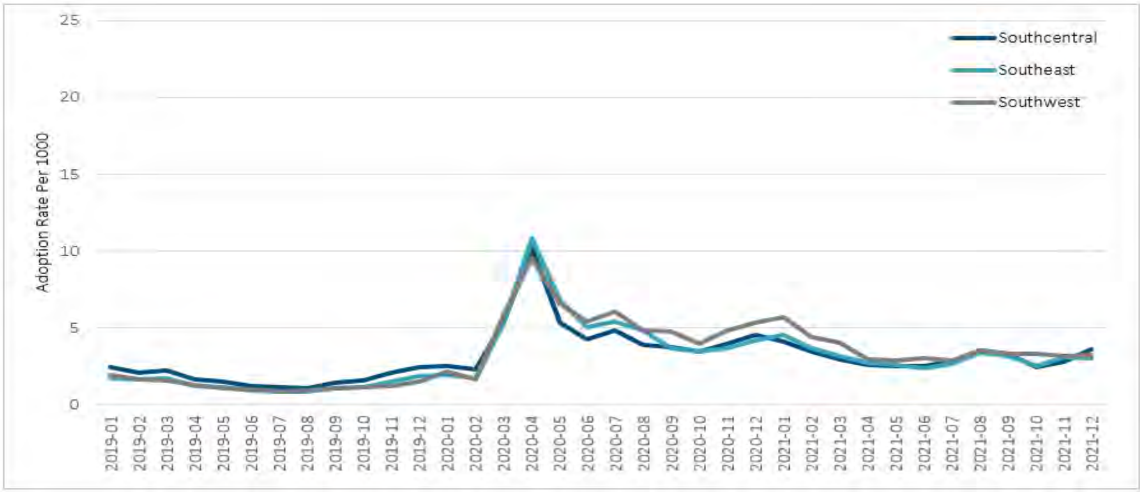


Figure 13

MEDICARE ADOPTION RATE BY REGION — NORTH REGIONS

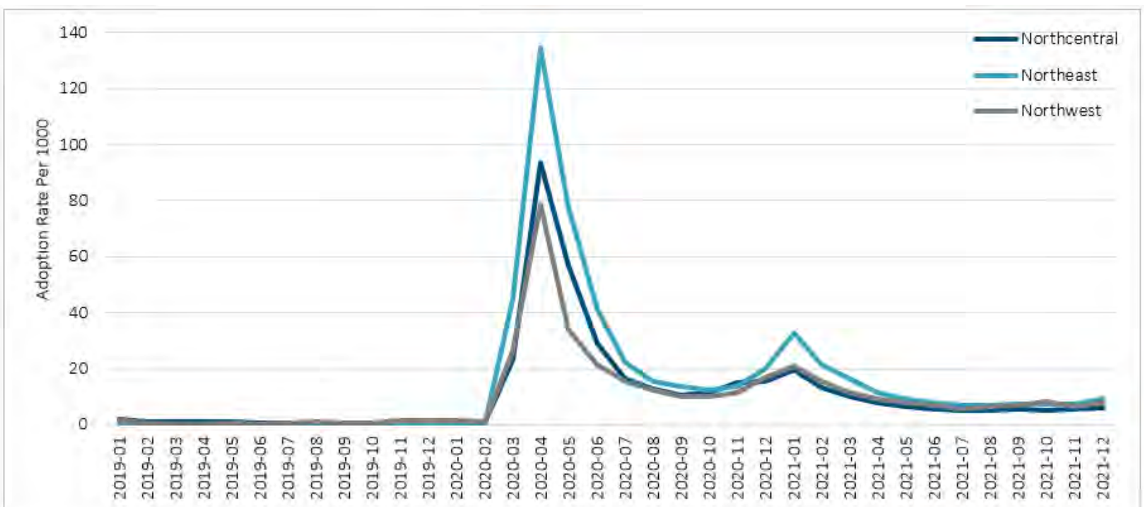
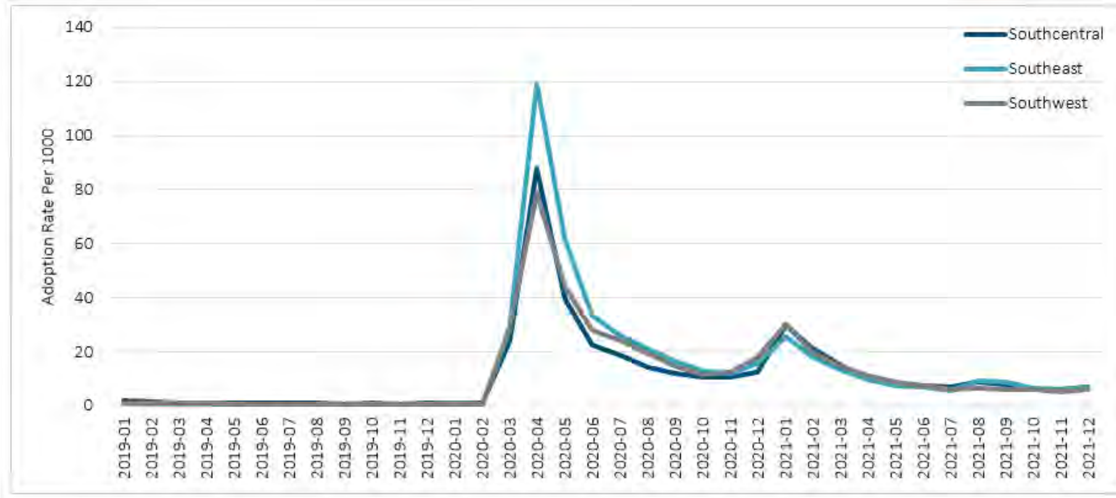


Figure 14
MEDICARE ADOPTION RATE BY REGION — SOUTH REGIONS



2.4. CODING AND DOCUMENTATION

Coding and documentation are critical to Medicare Advantage Organizations (MAOs) financial performance. Plans that can work with providers to align actual risk with coded risk and conduct and code clinical interventions based on evidence-based medicine and the CMS Star program guidelines are rewarded in the bid process by being able to offer more attractive benefits to members than plans that may be less effective in those areas. One of the primary drivers of successful coding and documentation is getting members to complete their annual wellness visit.

CMS provides flexibility in the place in which the annual visit can occur for coding and documentation. While these visits have traditionally occurred in a physician's office, both in-home visits and video telehealth visits are allowed. Given each Hierarchical Condition Classification (HCC) that can be coded is worth roughly $2,500 of revenue on average, significant emphasis is placed on making those visits happen in a setting that the member prefers. Prior to COVID-19, few of those visits were conducted via telehealth. However, COVID-19 caused both payers and providers to rethink the best ways for members to take advantage of this benefit. For many members, the telehealth option provided a safe means in which to conduct the visit, particularly in 2020. Patient safety remains a concern for many members, but the convenience to telehealth is becoming more broadly recognized. The ability to accommodate member's preferred place of service can influence the member experience part of a plan's Star rating. This section provides some observations and trends as to how the industry has adapted to the challenges of COVID-19 and the evolution of member preferences.

For this paper, we used the CMS-HCC software V2422.86.P1 model. We grouped the claims to a member, claim ID, date of service, and provider level. This grouping enabled us to utilize the CMS Software on a claim-level to assess diagnosis information. We analyzed all unique diagnosis codes from each claim. We then mapped each diagnosis to the HCC mapping within the HCC software. We did not map all diagnoses to an HCC. For this analysis, we did not exclude claims that did not have a valid procedure code combination with place of service setting, because the intent of this analysis was to identify additive HCCs as opposed to analyzing the potential implications on additive risk score.

We used three key calculated fields to assess potential implication on HCCs:

- The first calculation is the total diagnoses on a claim.

   - This metric is important in first differentiating whether telehealth claims have substantially different diagnosis than other types of E&M claims. E&M claims that have significantly more or less diagnosis will result in different HCC counts that would make comparison difficult.
- The second calculation is all diagnoses that triggered an HCC.
   - Because there are multiple diagnoses mapped to a unique HCC, this metric is valuable in understanding the coding practices when comparing settings.
- The third calculation is the sum of all unique HCCs on a claim.
   - Because risk adjustment is completed on a unique HCC per-member basis, identifying unique HCCs per claim are more relevant than total HCCs (calculation 2) when considering potential risk score impacts.

Optum performed various analysis to compare HCC for telehealth vs. nontelehealth by claim group and procedure group, by pre- and post-peak COVID-19, and by first and last telehealth visit. Please see the detailed analysis below.

Key Findings

- There is no clear evidence of less HHS HCC coding for telehealth visits.
- Providers are able to keep up with coding practices due to enhancements in technology.

CLAIM GROUP AND PROCEDURE GROUP SUMMARIES

Optum summarized all the E&M claims by telehealth and nontelehealth to compare the HCC trigger rates detailed above. To ascertain the true effect telehealth has on a coding and documentation perspective, a deeper cut of grouping is required for that analysis: claim groupings and procedure groupings. For purposes of HCC analysis, we assigned procedure groupings as shown in the Appendix 8.

Table 7

TELEHEALTH HCC SUMMARY – TELEHEATH VS. NONTELEHEALTH

Aggregate Comparison of Telehealth to Nontelehealth	Average Diagnosis on Header-Level Claim	Average Unique HCCs Triggered
Telehealth	3.19	0.78
Nontelehealth	3.40	0.88
Ratio		**0.89**

As illustrated in tables 8-10, most of the telehealth claims are within the physician visit and mental health buckets. The average HCCs triggered/captured are significantly higher in a mental health setting than physician setting (see Table 8).

Table 8

TELEHEALTH HCC SUMMARY BY CLAIM GROUPS

Claim Group	Members	Claims	Average Diagnosis on Header-Level Claim	Average Diagnosis, Which Triggers an HCC, Under Header-Level Claim	Average HCCs Triggered Under Header-Level Claim
Physician Visit	178,455	494,335	3.30	0.72	0.68
Mental Health	24,341	102,474	2.38	1.12	1.07
Nursing	5,097	21,649	3.55	1.42	1.38
Physician Other	5,251	12,637	4.19	1.30	1.24
Wellness	3,745	3,855	4.57	0.67	0.64
Transitional Care	1,941	2,154	3.99	1.29	1.23
Rehab	8	8	2.50	1.00	0.88
Nutrition Therapy	0	0	0.00	0.00	0.00

In every major claim grouping, the average HCCs triggered/captured are higher than aggregate comparison to their nontelehealth counterparts, except in the category of physician visit (see Table 9). However, both physician visit and mental health (most telehealth claims) are below the average HCC trigger rate than their nontelehealth counterparts.

Table 9

NONTELEHEALTH HCC SUMMARY BY CLAIM GROUPS

Claim Group	Members	Claims	Average Diagnosis on Header-Level Claim	Average Diagnosis, Which Triggers an HCC, Under Header-Level Claim	Average HCCs Triggered Under Header-Level Claim	Ratio of Average HCCs Triggered Telehealth to Nontelehealth	Percentage of Total Nontelehealth claims
Physician Visit	584,939	8,472,191	3.43	0.91	0.86	0.79	82.5%
Mental Health	40,248	246,377	2.09	1.14	1.10	0.98	2.4%
Nursing	36,245	448,352	3.74	1.33	1.29	1.07	4.4%
Physician Other	264,650	949,538	3.13	0.85	0.78	1.59	9.2%
Wellness	103,944	121,716	4.88	0.69	0.65	0.98	1.2%
Transitional Care	20,531	25,396	4.05	1.24	1.18	1.04	0.2%
Rehab	2,436	5,660	4.12	0.33	0.31	2.84	0.1%
Nutrition Therapy	23	28	3.96	1.39	1.32	0.00	0.0%

The detail of claim group only is not granular enough of a view to understand the relationship between telehealth and nontelehealth claims. The combination of procedure group and claim group shows that there is additional nuance to the HCC trigger comparison. A large portion of the physician visit cohort for nontelehealth falls into CMS-Hospital-OBS-and-IP, which has very little telehealth utilization. Once removing those from the comparison, we see that telehealth has a higher HCC trigger rate than its counter parts (see Table 10).

Table 10

NONTELEHEALTH HCC SUMMARY BY CLAIM GROUPS, PRODUCE CATEGORY

Claim Group	Procedure Category	Telehealth Claims	Average Unique HCCs Triggered (Telehealth)	Nontelehealth Claims	Average Unique HCCs Triggered (Nontelehealth)	Ratio of Average HCCs Triggered Telehealth to Nontelehealth	Percentage of Total Nontelehealth Claims
Physician Visit	**CMS-OFFICE-AND-OP**	403,306	0.66	5,747,295	0.59	1.13	66.2%
Physician Visit	**CMS-VIRTUAL**	85,248	0.71	0	0.00		0.0%
Mental Health	**CMS-OFFICE-AND-OP**	72,982	1.09	98,141	1.04	1.05	1.1%
Physician Visit	**CMS-HOSPITAL-OBS-AND-IP**	5,777	1.15	2,724,896	1.43	0.80	31.4%
Mental Health	**CMS-VIRTUAL**	5,051	1.06	0	0.00		0.0%
Mental Health	**CMS-HOSPITAL-OBS-AND-IP**	3,059	1.23	106,922	1.16	1.07	1.2%

As Table 10 shows, when comparing CMS-Office-and-OP setting, the nontelehealth visits relative to their telehealth counterparts trigger HCCs at a lower rate, both in a physician setting and a mental health setting. That begs the question: Is telehealth more effective at generating HCCs than nontelehealth claims?

With the data above, it is impossible to definitively answer that question; However, the data strongly suggests potential gaps in coding and documentation by moving care to a primarily telehealth place of service may be a perception bias Further analysis needs to be done on a provider-specialty-to-provider-specialty basis to make any assertion on telehealth overtaking nontelehealth as a primary source of patient-to-provider interactions. Furthermore, an analysis of only HCC trigger rates will not be substantial in arguing that telehealth is as effective as nontelehealth claims, because patient success will largely be driven by other metrics that are not shown in a coding and documentation analysis. The key point remains, in a shift to a largely digital world, providers seem be able to keep up with appropriate coding practices, despite not physically seeing patients face-to-face, which was a major inquiry at the crux of the pandemic in early 2020.

ASSESSING PRE-COVID-19 AND POST-PEAK COVID-19 HCC TRENDS

It may be impossible to truly assess the post-peak covid-19 impact on HCC trigger rate, because telehealth utilization was so low leading up to the pandemic (see Table 11); however, the data indicates that there was no significant up-coding effort underway in a telehealth setting if we assume a similar pre-covid-19 trend to its nontelehealth counterparts.

Table 11

NONTELEHEALTH HCC SUMMARY BY CLAIM GROUPS, PRODUCE CATEGORY, TIME FRAME

Claim Group	Procedure Category	Time Frame	Telehealth Claims	Average Unique HCCs Triggered (Telehealth)	Nontelehealth Claims	Average Unique HCCs Triggered (Nontelehealth)	Ratio of Average HCCs Triggered Telehealth to Nontelehealth
Physician Visit	CMS-OFFICE-AND-OP	Jan-Feb 2019	163	0.59	320,081	0.59	0.99
Physician Visit	CMS-OFFICE-AND-OP	Mar-Dec 2019	1,238	0.90	1,603,690	0.60	1.50
Physician Visit	CMS-OFFICE-AND-OP	Jan-Feb 2020	275	0.63	258,149	0.62	1.02
Physician Visit	CMS-OFFICE-AND-OP	Mar-Dec 2020	181,875	0.68	969,736	0.62	1.09
Physician Visit	CMS-OFFICE-AND-OP	Jan-Feb 2021	62,242	0.66	395,638	0.57	1.15
Physician Visit	CMS-OFFICE-AND-OP	Mar-Dec 2021	157,513	0.65	2,200,001	0.56	1.16

HCC TRENDS FOR MEMBERS WITH MULTIPLE TELEHEALTH EPISODE — FIRST VS. LAST TELEHEALTH VISIT (AND EPISODE LEVEL VIEW)

The purpose of episode-level view is to assess the HCC trends between the first and last (and middle) telehealth visit for a particular episode. We designed this view to assess the HCC coding efforts for individuals who have one telehealth visit only versus patients who have multiple (and sometimes even on a cadence) telehealth visits.

"No Limit" vs "Limit" episodic approach:

1. No Limit — If a second telehealth visit occurred within the window, the counter restarted.
2. Limit — If an episode started and was given an N-day window, the counter was unable to restart (end date was fixed as start date + N).

Table 12 is an example of the date resetting that would occur under each approach for the instance of when a new episode occurred (e.g., a telehealth visit after the window ended) relative to when a new episode would start. For the rest of the analysis, we have assumed N to be a 30-day time window.

Table 12

EXAMPLES OF HOW EPISODE RESET UNDER "NO LIMIT" AND "LIMIT" SCENARIOS

Member ID	Telehealth DOS	No Limit End Date	Limit End Date	No Limit Episode ID	Limit Episode ID
1	Jan. 1, 2020	Jan. 31, 2020	Jan. 31, 2020	1	1
1	Jan. 30, 2020	Feb. 29, 2020	Jan. 31, 2020	1	1
1	Feb. 5, 2020	Mar. 6, 2020	Mar. 6, 2020	1	2
1	Apr. 1, 2020	May 1, 2020	May 1, 2020	2	3
1	Apr. 15, 2020	May 15, 2020	May 1, 2020	2	3
1	Apr. 30, 2020	May 30, 2020	May 1, 2020	2	3
1	May 15, 2020	Jun. 14, 2020	Jun. 14, 2020	2	4
1	Jun. 10, 2020	Jul. 10, 2020	Jun 14, 2020	2	4

COMPARING PATIENTS WITH ONE VS MULTIPLE TYPES OF TELEHEALTH VISITS (PHYSICIAN VISIT/CMS-OFFICE-AND-OP ONLY)

As Table 13 illustrates, since the start of COVID-19, patients who have multiple telehealth visits on average have a 15.4% higher HCC trigger rate on their first visit than patients who only have one telehealth visit. In addition, patients who have multiple visits see an eventual 3% increase in total HCCs captured by the final visit in the measurement period.

Table 13

FIRST TELEHEALTH VISIT VS. LAST TELEHEALTH VISIT

First Telehealth Claim	Members	Claims	Average Diagnosis on Header-Level Claim	Average Diagnosis, Which Triggers an HCC, Under Header-Level Claim	Average HCCs Triggered Under Header-Level Claim
Members Having Multiple TH Visits; First Visit	81,016	81,016	3.344	0.699	0.659
Members Having One TH Visit Only	73,195	73,195	3.099	0.607	0.571
Members Having Multiple TH Visits; Final Visit	81,016	81,016	3.268	0.721	0.679

A deeper view into patients with multiple telehealth visits shows that as a member has more episodes, their average HCC trigger rate increases over time (Table 13). This should not come as a surprise, as sicker members generally utilize a higher number of services/care.

Table 14

PATIENT'S FINAL TELEHEALTH VISIT BASED ON TOTAL EPISODE COUNT

	Limit					No limit				
Episode Number	Members	Claims	Average Diagnosis on Header-Level Claim	Average Diagnosis, Which Triggers an HCC, Under Header-Level Claim	Average HCCs Triggered Under Header-Level Claim	Members	Claims	Average Diagnosis on Header-Level Claim	Average Diagnosis, Which Triggers an HCC, Under Header-Level Claim	Average HCCs Triggered Under Header-Level Claim
2	34,183	34,183	3.187	0.682	0.642	35,132	35,132	3.199	0.685	0.645
3	16,729	16,729	3.322	0.754	0.709	17,261	17,261	3.326	0.754	0.709
4	9,034	9,034	3.388	0.798	0.757	8,872	8,872	3.409	0.805	0.764
5	5,078	5,078	3.451	0.813	0.769	4,479	4,479	3.442	0.826	0.778
5+	6,714	6,714	3.548	0.810	0.766	4,349	4,349	3.565	0.829	0.785

None of the above information should come as a surprise. However, it does make a relatively bold statement because it relates to telehealth claims capacity to keep up with clinical coding and documentation demands. MAOs are consistently looking for an edge in maintaining efficacious coding practices. For patients who continue with their telehealth visits, there is a consistent increase in the HCCs that get coded. Are people really getting 3% sicker in an

18-month window? Perhaps. However, an alternative thought is that as providers more willingly enter the digital world, their habits follow them. Providers are able to update coding measures in real time due to the enhancements in technology and can capture all the coding and document needs while having face-to-face interactions via a screen.

The above are observation and findings based on Optum benchmarking data. Further analysis needs to be done to validate whether coding increased and what is causing HCCs triggered to go up from a telehealth utilizer's first visit to the last. As the telehealth data has shown, physicians should be able to keep up with coding practices due to enhancements in technology.

2.5. PROJECTED HEALTH CARE OUTCOMES

The impact that the COVID-19 has had on public health, directly affected telehealth utilization. We have observed that telehealth for MHSA and E&M had a significant difference in trends. We can see that after a few months of lockdown due to COVID-19, telehealth utilization increased for MHSA. On the other hand, E&M peaks are more consistent with the peak of COVID-19 cases observed during 2020 and 2021 (please refer to Section 1.2). Therefore, we have separated our projection analysis by LOB and service types (E&M, MHSA).

COVID-19 and its effects on society have generated a large amount of time-series data, such as daily confirmed cases, deaths, recoveries, hospitalizations, testing and more. Recurrent Neural Networks (RNNs) models, like long short-term memory (LSTM), gated recurrent unit (GRU) and bidirectional LSTM (BiLSTM), are well-suited to model and analyze this type of data as they can handle sequential information.

We focus on this section to build a telehealth utilization predictive analytic technique. To develop the predictive model, we used a total of 41 monthly observations from January 2019 to May 2022. We analyzed some variants of RNNs: LSTM networks, GRU, and BiLSTM.

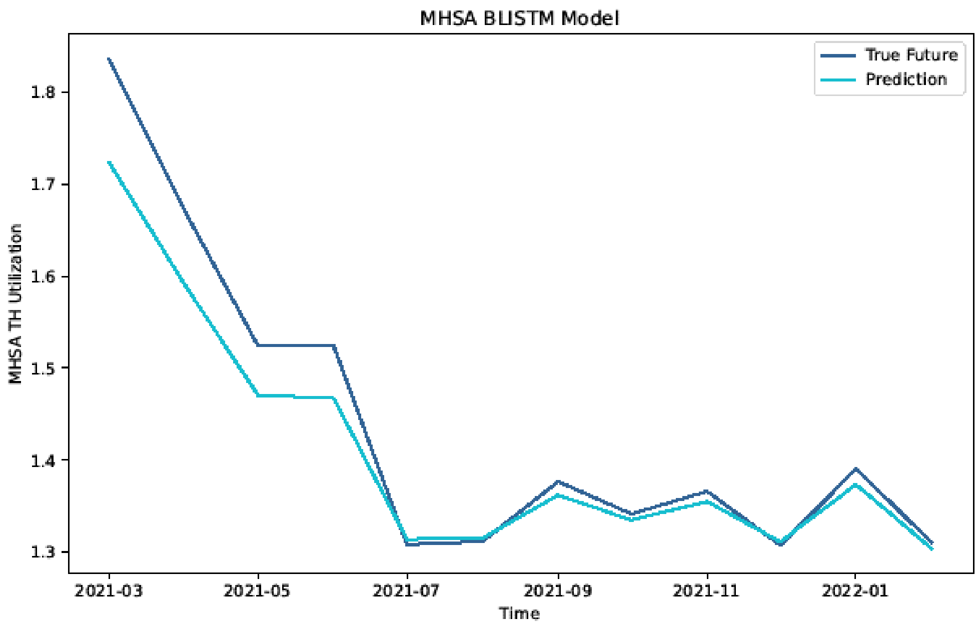
The best fit models were built based on the minimum values of root mean squared error (RMSE) and mean absolute error. After evaluating the model's fit, we created projections for the following eight months for future utilization rates. Refer to Appendix 9 for a detailed description of the models. The graphs below show the prediction by line of business by type of services.

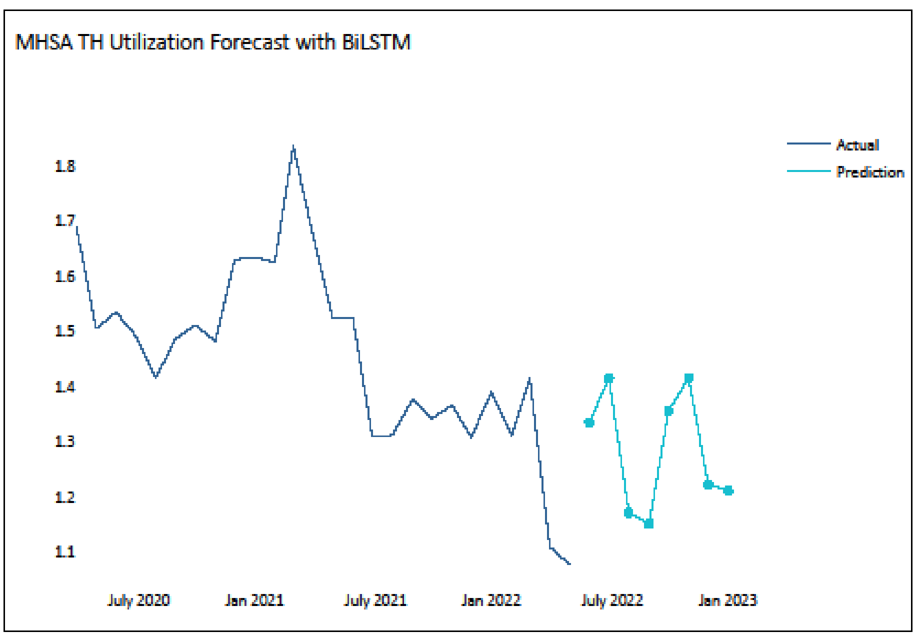
Key Findings

- The projection results show that telehealth utilization will stabilize at a higher level than before COVID-19.
- The projection results are purely based on historical data and model parameters without any actuarial judgement.
- There will be a seasonal impact on telehealth utilization, for example, increased E&M visits during winter months.

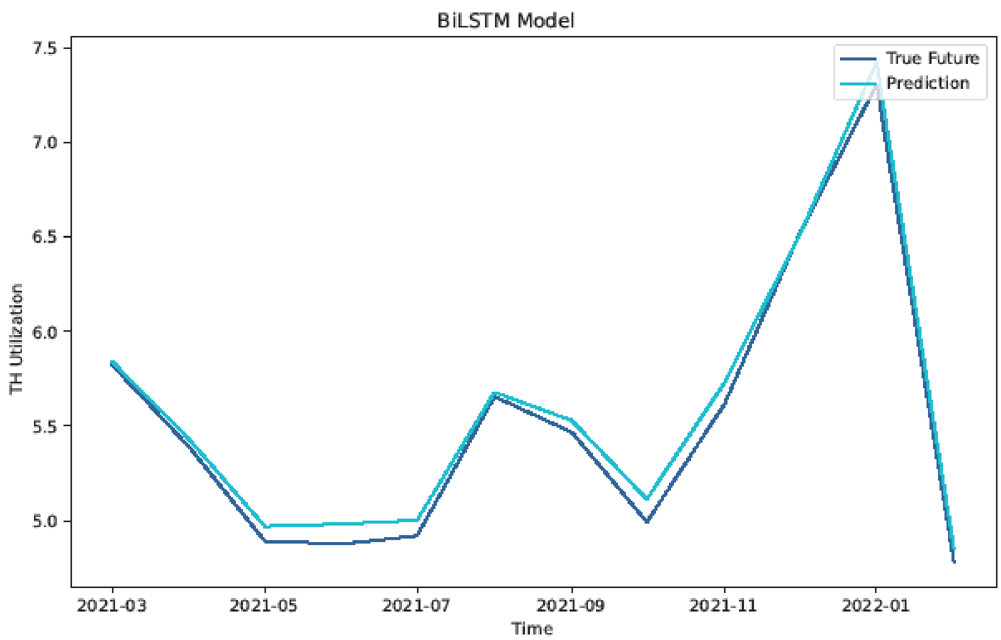
Figure 15

COMMERCIAL PREDICTION MHSA





COMMERCIAL E&M



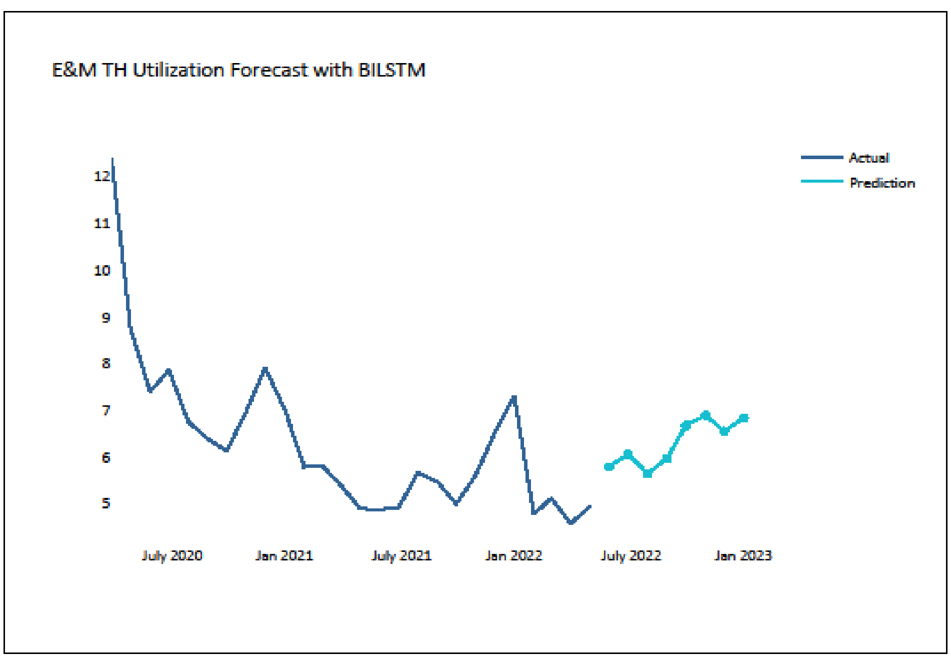
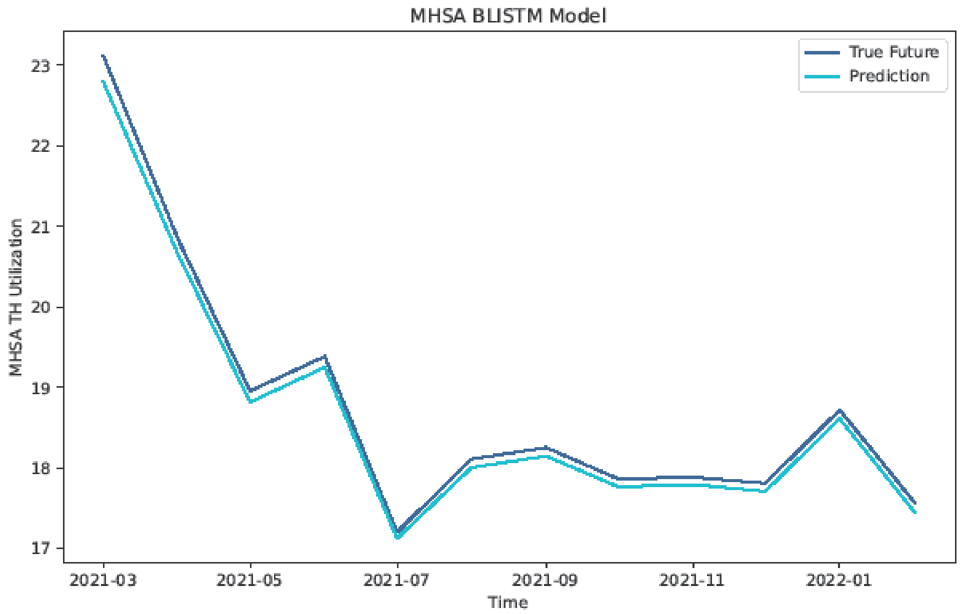
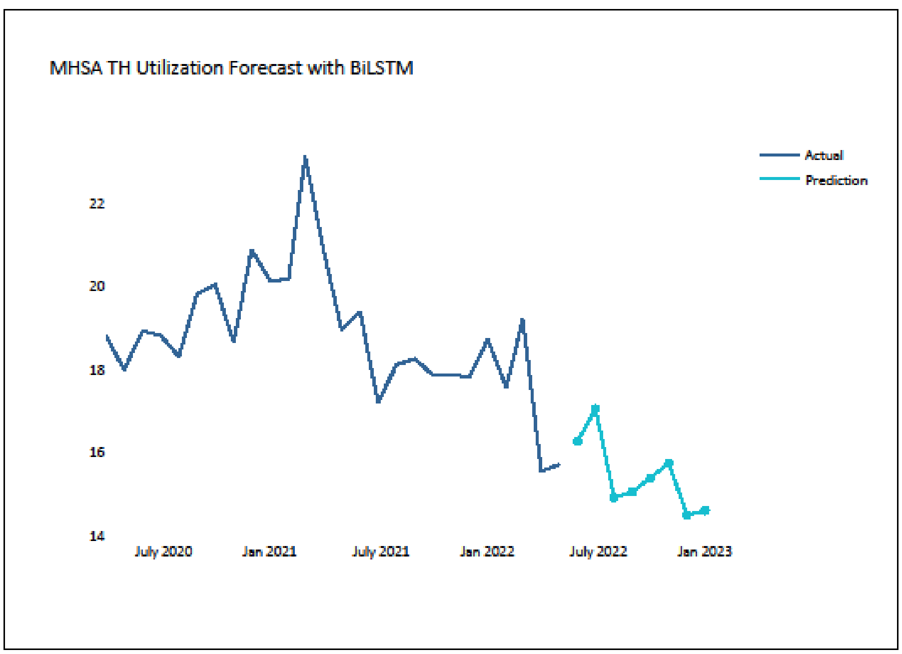
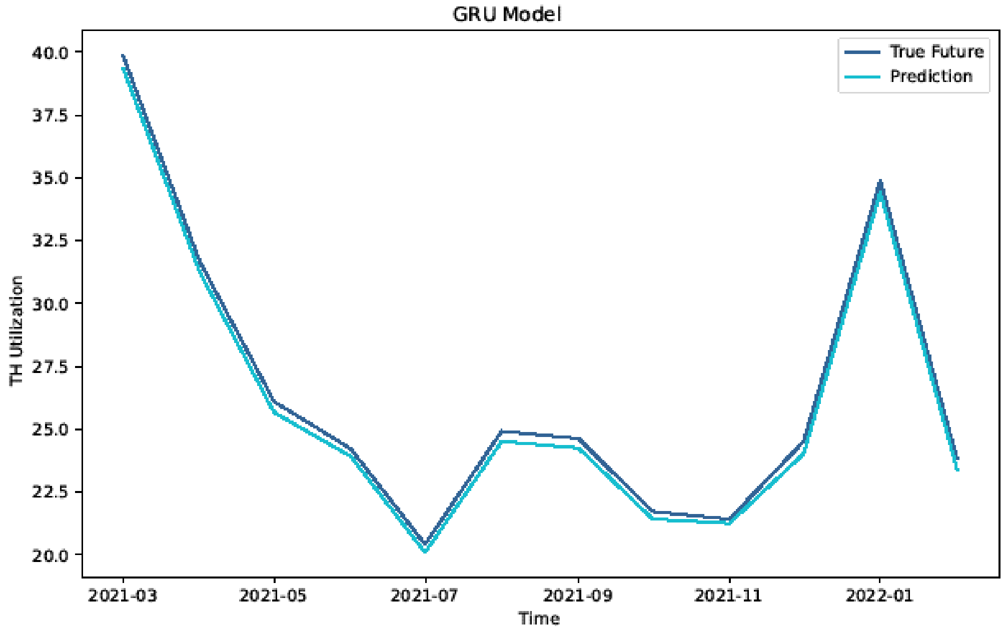


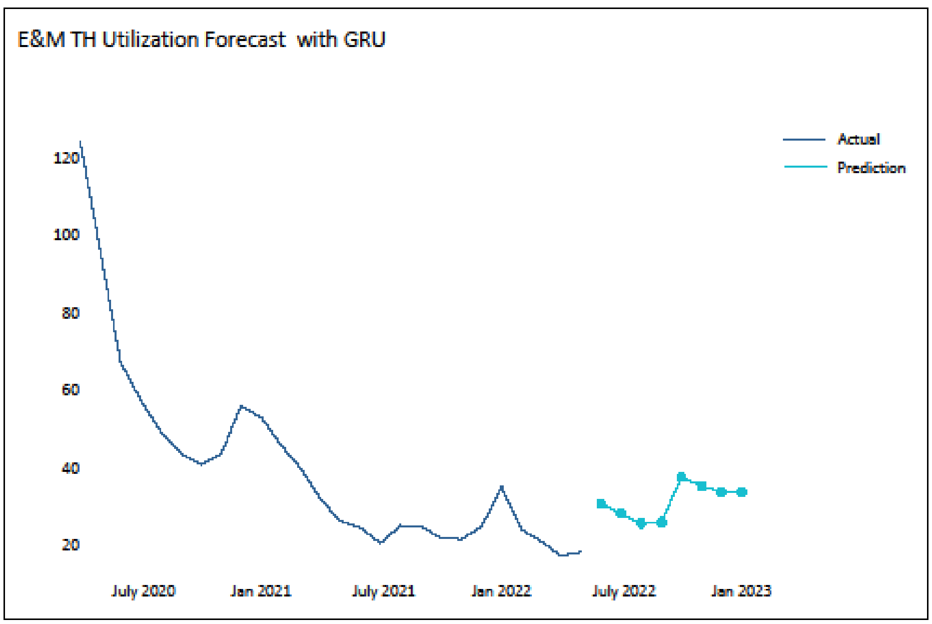
Figure 16
MEDICARE POPULATION PREDICTION - MEDICARE MHSA





MEDICARE E&M


GRU Model
True Future
Prediction
TH Utilization
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
2021-03
2021-05
2021-07
2021-09
2021-11
2022-01
Time


E&M TH Utilization Forecast with GRU
Actual
Prediction
120
100
80
60
40
20
July 2020
Jan 2021
July 2021
Jan 2022
July 2022
Jan 2023

Section 3: Provider Level Services

The goal of provider-level analysis is to help address the questions of what providers are equipped to quickly embrace new technologies and what the trends are for telehealth service before, during and after COVID-19 for different providers.

3.1. METHODOLOGY

For the purpose of this provider-level analysis, we excluded those traditional telehealth providers from the summary for all years and only focused on nontraditional telehealth providers. We identified traditional telehealth providers as all providers whose proportion of claims were at least 90% telehealth in 2019.

We summarized the top 10 nontraditional telehealth providers based on visit counts by line of business (commercial vs. Medicare) and type of service (E&M or MHSA). Servicing provider NPI identified providers. We did not try to group providers or identify ownership. For privacy concerns, we have masked provider names. The percentage of service share is defined as the number of telehealth visits as a percentage of total. The percentage of market share is defined as the number of telehealth services for the particular provider over the total telehealth services for the same type of service (E&M or MHSA) for all providers available in the analysis.

3.2. PROVIDER ANALYSIS OBSERVATIONS AND FINDINGS

Key Findings

- We observed different provider patterns for telehealth services between commercial and Medicare and E&M and MHSA services.
- The common theme is that some providers responded to the need during COVID-19 to develop infrastructure for telehealth service quickly, while a lot more providers are gradually catching up.
- Providers will continue to provide telehealth services in a larger scale following COVID-19 compared to pre-COVID-19.

For the commercial population:

- Most of the top 10 E&M providers in 2020 (seven out of 10) persisted as top providers in 2021.
- Conversely, only three of the top MHSA providers in 2020 persisted as top providers in 2021.
- The top 10 providers in both E&M and MHSA control nearly all the market share (over 90%).

For the Medicare population:

- Most of top 10 MHSA providers in 2020 (six out of 10) persisted as top providers in 2021.
- Conversely, only four of the top E&M providers in 2020 persisted as top provider in 2021.
- The top 10 providers in both E&M and MHSA control a much smaller portion of the market share, about half, compared to the commercial market.

Table 15

COMMERCIAL E&M TELEHEALTH SERVICE TOP 10 PROVIDERS

2020	E&M			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 1	12,737	44.1%	60.7%
2	Provider 2	3,648	9.7%	17.4%
3	Provider 3	953	36.4%	4.5%
4	Provider 4	538	20.2%	2.6%
5	Provider 5	474	2.8%	2.3%
6	Provider 6	427	10.6%	2.0%
7	Provider 7	348	8.2%	1.7%
8	Provider 8	342	1.7%	1.6%
9	Provider 9	315	6.9%	1.5%
10	Provider 10	273	100.0%	1.3%

2021	E&M			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 1	16,140	38.91%	74.03%
2	Provider 2	2,239	6.44%	10.27%
3	Provider 11	683	100.00%	3.13%
4	Provider 5	669	3.25%	3.07%
5	Provider 3	507	18.05%	2.33%
6	Provider 8	275	1.09%	1.26%
7	Provider 12	233	6.90%	1.07%
8	Provider 4	197	7.83%	0.90%
9	Provider 13	192	2.65%	0.88%
10	Provider 10	133	100.00%	0.61%

Table 16

COMMERCIAL MHSA TELEHEALTH SERVICE TOP 10 PROVIDERS

2020	MHSA			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 29	925	44.0%	28.2%
2	Provider 30	745	48.3%	22.7%
3	Provider 31	611	32.9%	18.6%
4	Provider 32	313	47.1%	9.5%
5	Provider 33	104	52.3%	3.2%
6	Provider 34	65	7.0%	2.0%
7	Provider 35	65	4.9%	2.0%
8	Provider 36	63	2.6%	1.9%
9	Provider 37	61	3.1%	1.9%
10	Provider 38	51	7.5%	1.6%

2021	MHSA			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 39	678	50.26%	38.68%
2	Provider 31	361	15.14%	20.59%
3	Provider 32	266	45.86%	15.17%
4	Provider 29	242	14.14%	13.80%
5	Provider 40	34	4.52%	1.94%
6	Provider 41	23	4.07%	1.31%
7	Provider 42	19	2.87%	0.97%
8	Provider 43	17	2.53%	0.97%
9	Provider 44	17	0.49%	0.91%
10	Provider 45	16	2.49%	0.80%

Table 17

MEDICARE E&M TELEHEALTH SERVICE TOP 10 PROVIDERS

2020	E&M			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 14	5,558	41.9%	16.3%
2	Provider 15	2,581	44.9%	7.6%
3	Provider 16	1,374	35.1%	4.0%
4	Provider 17	1,308	37.6%	3.8%
5	Provider 18	1,218	48.0%	3.6%
6	Provider 19	1,091	46.1%	3.2%
7	Provider 20	1,032	100.0%	3.0%
8	Provider 21	1,004	25.6%	2.9%
9	Provider 22	872	36.1%	2.6%
10	Provider 23	767	11.8%	2.3%

2021	E&M			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 11	4,261	4.14%	18.17%
2	Provider 14	2,896	30.79%	12.35%
3	Provider 21	1,170	25.12%	4.99%
4	Provider 18	1,035	39.07%	4.41%
5	Provider 19	982	29.37%	4.19%
6	Provider 24	941	5.97%	4.01%
7	Provider 25	918	6.75%	3.91%
8	Provider 26	791	24.80%	3.37%
9	Provider 27	788	38.82%	3.36%
10	Provider 28	669	22.27%	2.85%

Table 18

MEDICARE MHSA TELEHEALTH SERVICE TOP 10 PROVIDERS

2020	MHSA			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 46	1,856	70.8%	6.4%
2	Provider 47	1,526	100.0%	5.2%
3	Provider 48	1,421	59.7%	4.9%
4	Provider 49	1,195	51.4%	4.1%
5	Provider 50	1,193	60.3%	4.1%
6	Provider 51	1,109	80.3%	3.8%
7	Provider 52	1,102	72.3%	3.8%
8	Provider 53	992	76.2%	3.4%
9	Provider 54	950	51.4%	3.3%
10	Provider 55	879	79.0%	3.0%

2021	MHSA			
Rank	Top Providers	Visits	% Service Share	% Market Share
1	Provider 53	2,320	100.00%	8.94%
2	Provider 46	2,229	73.20%	8.59%
3	Provider 56	1,336	62.96%	5.15%
4	Provider 52	1,014	75.62%	3.91%
5	Provider 57	904	100.00%	3.48%
6	Provider 55	857	71.84%	3.30%
7	Provider 58	826	100.00%	3.18%
8	Provider 54	783	30.26%	3.02%
9	Provider 59	755	100.00%	2.91%
10	Provider 49	726	32.96%	2.80%

Section 4: Future Outlook

While the COVID-19 pandemic has created an environment where telehealth services have expanded significantly beyond the scope of services previously offered and many providers continue to offer services via telehealth even now that most pandemic restrictions have been relaxed, that may or may not continue. The future outlook for telehealth services is tougher to predict with a high degree of confidence because it involves many factors including patient behavior.

It is likely that some patients will continue to demand the convenience of telehealth services for at least some types of services, and providers who have found that they can effectively, safely, and efficiently deliver telehealth services will continue to offer those services to patients. That may depend in large part on whether the provision of telehealth services is economically feasible for providers if the favorable pandemic provider payment policies are no longer in place.

Note that much of the easing of restrictions on payment policies (typically offering the same payments for telehealth services as for in-person visits) may not continue, given that most of the other pandemic restrictions have now been relaxed. If payment rates change, a significant drop in the use of telehealth services may occur, even if patient demand remains high. That may depend on the relative efficiency of the provision of telehealth services relative to in-person visits. If providers are able to see more patients in the same amount of time via telehealth, lower-per-visit reimbursement for telehealth visits with the same or higher total payments to providers may occur. The time periods included in the data underlying this report do not reflect significant environmental changes post-peak COVID-19 so it is too soon to study those changes if they do occur.

In addition to payment policies, other less-restrictive policies may still be in place, including the scope of services that certain providers may supply in a virtual environment. If those policies become more restrictive, less future usage of telehealth services may occur. Whether those policies will change in the future is unknown. Given the relative success experienced in delivering care during the pandemic, it is quite possible that many of these less-restrictive policies may remain in effect in the future.

While writing this paper, the Biden administration announced the end of the public health emergency (PHE) related to COVID-19 would end in May of 2023. Many of the more flexible policies adopted during the pandemic were tied to the PHE and will sunset at various times after the PHE officially ended. The Consolidated Appropriations Act 2023 (CAA) separately extended key features related to coverage of telehealth services in the Medicare program through Dec. 31, 2024, and are no longer tied to the PHE’s status. The more flexible treatment of telehealth services will now continue for Medicare patients for a considerable time. To the extent that health plans follow similar policies as Medicare for their commercial populations, those flexible policies may continue for patients as well. It is possible that legislative changes will further extend those policies, so whether and when these policies will change remains an open question.

Regardless of the future policy environment, some patients and providers may prefer to receive or deliver care in an in-person environment regardless of whether telehealth services are an option. Others may prefer a telehealth environment due to increased convenience or other factors. The extent to which patients and providers have such preferences and how many there are remains unknown and may be variable into the future as the U.S. moves further from the pandemic disruption. The pandemic period can be characterized as one where the great majority of nonemergency care was provided via telehealth by necessity. While some of that care has already returned to the in-person environment, data suggests that telehealth rates remain significantly higher than pre-pandemic levels. How much of that care providers will continue to deliver in a telehealth environment in the future is an open question that future research will need to address. Because much of the telehealth utilization during the pandemic was driven by necessity rather than patient or provider preferences, important questions remain about what care providers can most effectively or appropriately deliver via telehealth. As the U.S. moves into the post-peak COVID-

19 environment, further research may address some of those questions as mostly preferences rather than necessity drive the location of care. What is not an open question is that the amount of literature on digital health will continue to increase as more data becomes available and the definition of digital health expands.

This paper provides a snapshot of telehealth utilization in a unique environment largely driven by pandemic considerations and policies. As future data becomes available under potentially different policies, different utilization patterns may emerge. Patient and provider preferences, quality considerations and the effects of future policy changes will likely drive those patterns. This paper provides an analytical framework that may be valuable for researchers as emerging data becomes available.

Section 5: Acknowledgments

The authors' deepest gratitude goes to those without whose efforts this project could not have come to fruition: the Project Oversight Group and those supporting this project on the Society of Actuaries research team. The individuals listed below committed both their time and deep actuarial knowledge to provide constructive feedback, assuring this paper has broad applicability and is focused on areas most relevant to the actuarial profession.

Project Oversight Group:

Kenneth Avner, FSA, MAAA

Joan Barrett, FSA, MAAA

Rafi Herzfeld, FSA, MAAA

Jackie Lee, FSA, MAAA

Jim Mange, FSA, MAAA

Mitchell Momanyi, FSA, MAAA

Dan Mulhern, FSA, MAAA

Tri Pham, FSA, MAAA

Robert Roffman, FSA, MAAA

Sudha Shenoy, FSA, MAAA, CERA

Society of Actuaries Research Team:

Achilles Natsis, FSA, MAAA

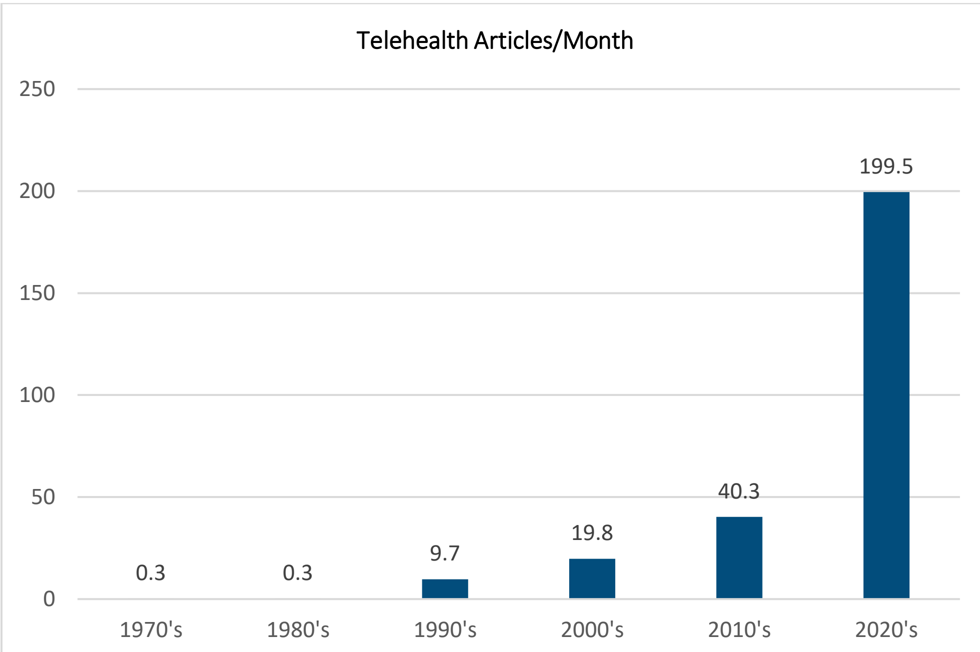
Erika Schulty

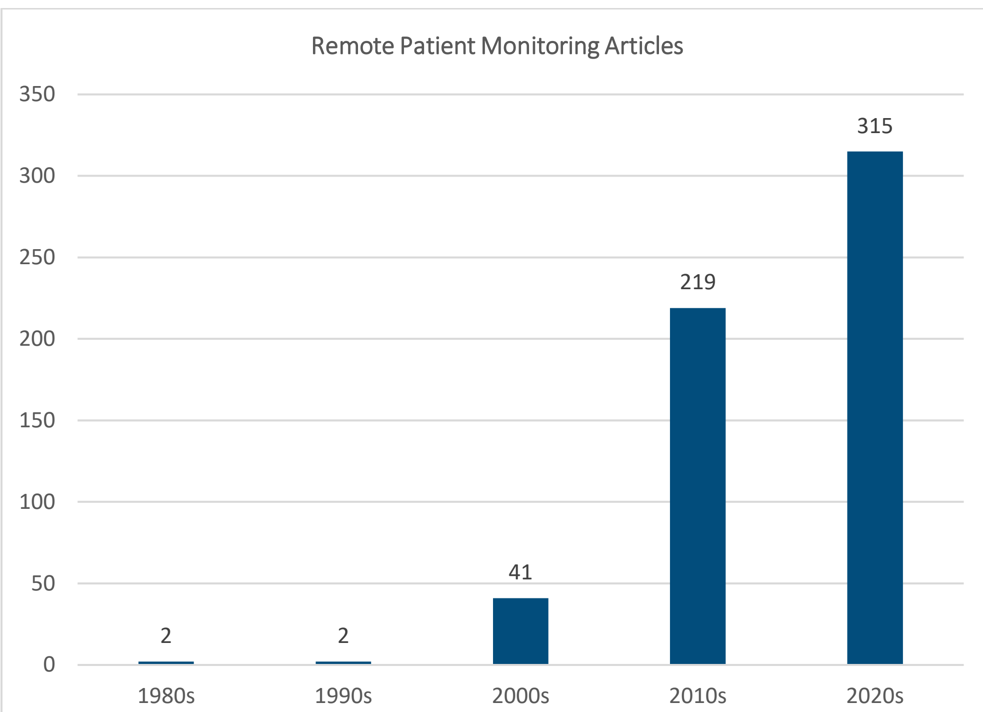
Appendix 1: Literature Review Activity by Decade

The following charts illustrate the growth in published articles focused on telehealth and remote patient monitoring.

Figure A1-1

TELEHEALTH/TELEMEDICINE PUBLICATION RATES





Appendix 2: Literature Review Using Quintuple Aim Framework

A. THE OPPORTUNITY THAT TELEHEALTH REPRESENTS — QUINTUPLE AIMS

The quintuple aims as both payers and providers generally agree to are:

1. Improved patient experience.
2. Improved patient health.
3. Reduced cost of health care.
4. Improved provider experience.
5. Improved health equity.

The following subsections summarize the literature relative to the aims noted above.

A.1. AIM 1: IMPROVING PATIENT EXPERIENCE

The first of the quintuple aims underscores the fact that the ultimate source of the health care system's effectiveness derives from those who receive health care services. The patient experience comprises all the interactions patients have in accessing and navigating the health care system to receive care as well as the interactions they have with health care providers to manage their health. Therefore, a telehealth-based improved experience means that patients have better and easier navigation with increased access to health care. It also means that their experiences with their health care providers will not be adversely affected by the change in delivery modality from in-person care to telehealth.

Improving access to health care was one of the original drivers for telehealth's growth. Clinicians needed more effective ways to provide health care to their patients, particularly those for whom distance or other factors (for example, patient disability or provider shortages) created barriers to in-person care. The COVID-19 pandemic dramatically enhanced the urgency of that need for better access. In addition, the problem of provider access is only going to get worse. According to a recent survey by the Commonwealth Fund, access to primary care is becoming a significant issue in the U.S. (FitzGerald et al. 2022). One of the contributing factors is the growing shortage of physicians. The survey also noted that those shortages "disproportionately affect predominantly Black and Latinx communities and rural areas, exacerbating disparities that have widened during the COVID-19 pandemic." The pandemic has contributed to that problem by increasing provider burnout, causing many to leave primary care (Abbasi, J. 2022). Provider shortages are especially a problem for mental health, where they leave more than 90% of those living in rural areas without adequate access to mental health services (Day et al. 2021). By enabling remote access to primary care and mental health providers, telehealth may be able to provide a partial solution to that problem. Rural communities are also affected by lack of access to specialty care, a problem that telehealth is also able to ameliorate.

Modern telehealth technology can enable patients to meet with providers without having to travel long distances and at times that can be more convenient for their schedules. That means that patients would have fewer costs associated with health care access, including lower direct costs (for example, time lost in travel or travel costs such as gasoline) as well as lower opportunity costs (time lost from work). The fact that telehealth can be delivered both online and via smartphone adds video to traditional telephonic communication. Today, approximately 85% of adult Americans have (Kolmar, C. 2022) and many already prefer mobile to online for interacting with their health care providers (Mitchell, H. 2021; Doximity, n.d.). That increases the ease with which patients receive their health care in a way that more closely approximates in-person care.

In addition to improving access to primary care, telehealth can also facilitate access to specialty care that might be needed, particularly in areas where specialists are not readily available. Finally, the increasing use of ever-improving connected devices to provide both initial and ongoing measurement of key health vital signs and behaviors makes it possible for health care providers to assist patients more effectively in diagnosing and managing both acute health problems and chronic health conditions. Taken together, all those factors mean that telehealth is likely to result in an improved patient experience regarding their ability to access the health care system when they need it. To what extent was that expectation fulfilled during the COVID-19 pandemic?

Telehealth Utilization Before and During COVID-19

While telehealth utilization was steadily increasing pre-pandemic, it still made up a small percentage of health care visits and of beneficiaries who were using telehealth. For example, in their analysis of rural Medicare fee-for-service telehealth utilization between 2010 and 2019, Barnett et al. (2021) found that the percentage of beneficiaries using telehealth grew by 23.1% annually from 0.2% in 2010 to 0.9% in 2019. Similarly, Cantor et al. (2021) noted that telehealth visits made up less than 1% of Medicare fee-for-service visits prior to the pandemic. And Day et al. (2021), in their analysis of telehealth utilization for mental health care within the Veterans Affairs (VA) system, reported a tenfold increase in the percentage of veterans receiving video telemental health care from 2018 to 2019.

The pandemic exponentially increased telehealth utilization as in-person visits were halted with the initial stay-at-home mandates and the surge of COVID-19 cases that were overwhelming the health care system. Providers and patients alike had to learn quickly how to use telehealth to stay in communication. Providers also needed telehealth to maintain revenues, especially during the pandemic's early phases. After an initial surge in telehealth visits in the early months of the pandemic, utilization declined significantly but remains substantially higher than pre-pandemic levels. That pattern is generally observed industry wide across health systems, insurer types, medical specialties, and patient demographic populations — see Appendix 3 for a summary of those observations.

Temporary/emergency policy changes, including a relaxation in the restrictions to the use of telehealth and parity in telehealth reimbursement, greatly and necessarily aided the shift to telehealth (Barnett et al. 2021). Those changes are also primarily responsible for current higher levels of telehealth utilization in times when in-person visits have again become possible without excess risk to patient and provider safety (Hamadi et al. 2021).

Telehealth has also contributed to improved access by decreasing the likelihood of missed appointments compared with in-person care (Adepojua et al. 2022; Alkilany et al. 2021; Bramati et al. 2022; Drerup et al. 2021; Franciosi et al. 2021). For example, Drerup et al. (2021) reported a telehealth primary care visit no-show rate of 7.5% compared with an in-patient primary care no-show rate of 36.1% during the pandemic; that rate was also lower than the baseline in-person no-show rate of 29.8%. In addition, telehealth has been shown to improve timely access to health care. Within a large integrated health care delivery system with equal access to telehealth and in-person scheduling, Graetz et al. (2022) reported that patients who chose telehealth had audio (telephonic) and video visits that were 49% and 35%, respectively, sooner than in-person visits (1.80 and 2.29 days, respectively, vs. 3.52 days). Those findings attest to the convenience of telehealth for patients.

However, improved access and a better patient experience have not always been uniform. The COVID-19-necessitated telehealth natural experiment also revealed issues that the healthcare industry and regulators need to address if telehealth benefits are not counterbalanced by reductions in health care equity. We discuss those issues under Aim 5 — Healthcare Equity.

Provider and Patient Satisfaction with Telehealth

As mentioned above, improved access to health care is not the only factor contributing to a better patient experience with the health care system. When telehealth communication is substituted for in-person care, there is a legitimate question of whether it will have a negative impact on provider-patient working relationships. Pre-pandemic, much of telehealth intervention for chronic health conditions such as heart failure, hypertension and diabetes centered on remote patient monitoring using connected devices. In addition, most telehealth communications were telephonic, although larger health care systems such as the VA were beginning to implement video communication (Balut et al. 2022; Jacobs et al. 2022). Video greatly improves the quality of a physician-patient interaction, but it also requires training of both professionals and patients to maximize effectiveness (Alkureishi et al. 2021). Provider and patient contracts need to be revised because there is some risk of not being able to capture issues that can be better caught during an in-person visit to make sure limitations are clearly identified.

Pre-pandemic surveys of patients receiving telehealth services showed that those services were, in fact, well-received (Day et al. 2020; Lo et al. 2022; Butzner, M, and Y. Cuffee 2021; Elliott et al. 2020; Truong et al. 2022).

However, given continual advancements in communication technology and provider/patient readiness, it is important to look at patient satisfaction with telehealth during the pandemic. To date, it appears that patients have and continue to well receive telehealth (Doximity, n.d.; De Biase et al. 2020; Drerup et al. 2021; Mehak, N., and R. Sharma 2021; Ahmad et al. 2021; Brunton et al. 2021; Ebbert et al. 2021; Finn et al. 2021; Johnson et al. 2021; Kintzle et al., n.d.; Phenicie, R., R.A. Wright, and J. Holzberg 2021; Sallam et al. 2021; Thomson, M.D., et al. 2021; Volcy et al. 2021; Nguyen, M.T., et al. 2022). That is the case despite the fact that the pandemic forced both providers and patients into a way of communicating with which they were not always familiar or for which they were not always well-prepared.

The main benefits of telehealth that patients listed included time saved due to less traveling, not finding parking and not sitting in waiting rooms; better accessibility; increased convenience; not needing to take time off from work or finding child care, and/or miss other appointments (Mehak, N., and R. Sharma 2021; Brunton et al. 2021). The main issues patients reported as problems with telehealth primarily were about lack of access and technological difficulties, although they also expressed concerns about privacy, being able to spend as much time with their physicians, and about physicians not being able to examine them properly (Drerup et al. 2021; Truong et al. 2022). Similarly, Thomson et al. (2021) found that patients with less internet access, lower health literacy and lower perceived stress tended to be less satisfied with telehealth. Interestingly, patient demographics such as age, gender and race did not seem to be strongly related to telehealth satisfaction, which speaks well with regard to Aim 5 — Healthcare Equity.

Also interesting is the finding that high satisfaction with telehealth coexists with patients still preferring in-person visits (Mitchell, H. 2021; Ahmad et al. 2021; Nguyen, M.T., et al. 2022; Hunsinger, N., R. Hammarlund, and K. Crapanzano 2021). At least two possible factors contribute to that seeming contradiction. The first is patients' reluctance to rate their providers poorly, thus driving up ratings but still meaning that in-person visits would be considered more desirable when there is a choice. The second factor is behavioral inertia. Patients and providers alike have been acculturated to expect health care to be delivered in person. In addition, as social creatures, people tend to value face-to-face social and professional interactions over less personal audio, visual or text/email interactions. While the pandemic's circumstances (mandates and fear of infection) forced people to give telehealth a chance and while people didn't find the experience to be overly disappointing and perhaps better in some respects compared with in-person visits, once things began to return to normal, people's tendency to want to maintain the status quo began to reassert itself. Neither of those possibilities need be taken as evidence that the U.S. should return to most patient visits being in person. However, they highlight the need to continue solving for the problems that make telehealth less desirable to some people in some circumstances.

In summary, telehealth appears to be mostly living up to its promise to improve patients' experience with the health care system. During a time when in-person access to care was not possible or preferable, telehealth enabled patients to stay connected with their health care providers. However, some of the same issues that were problems for telehealth access pre-pandemic will still need to be addressed. Otherwise, the increased integration of telehealth into health care delivery is likely to create inequities in health care.

A.2. AIM 2: IMPROVED PATIENT HEALTH

There are several reasons why telehealth is expected to be effective for helping patients achieve desirable health outcomes. By improving access to care, telehealth can assist in both the diagnosis and management of many acute and chronic conditions by facilitating ongoing continuity of care and more frequent and effective follow-ups. For example, clinically supervised remote monitoring of vital signs supplemented by audio/video telecommunication between patients and providers can facilitate effective initial treatment and ongoing management of many acute and chronic health conditions. Note, however, that this capability is limited by the availability of clinically validated telemedicine vital sign measurement processes. We discuss that in Subsection B of this Appendix.

Telehealth also has the potential to facilitate effective transitions between in-patient and home-based care. Thus, it is not surprising to find that most (but not all) studies demonstrate a beneficial impact of telehealth interventions on patient health across a variety of medical conditions and patient populations and in a variety of health care settings

(Balut et al. 2021; Truong et al. 2022; Flodgren et al. 2015; Bashshur et al. 2016; Kruse et al. 2017a; Kruse et al. 2017b; Shigekawa et al. 2018; Donelan et al. 2019; Harerimana B., C. Forchuk, and T. O'Regan 2019; Pekmezaris et al. 2019; Davis et al. 2020; Lin et al. 2020; Polonsky et al. 2020; Bhargava et al. 2021; Krzyzaniak et al. 2021; de Albornoz S.C., K. Siaa, and A. Harris, 2022; de Groot et al. 2021; Duryea et al. 2021; Kubes et al. 2021; Markert et al. 2021; Yatabe et al. 2021; Zhao et al. 2021; Aubert et al. 2022; Glennie, J.L., L. Berard, and F. Levrat-Guillen 2022; Lundström et al. 2022; Quinton et al. n.d.; Spina et al. 2022; Taylor et al. 2022; Saloner et al. 2022; Uhl et al. 2022). In this section, we look at a representative sampling of health outcomes associated with telehealth interventions.

Based on studies published both before and during the pandemic, for many types of health care, telehealth intervention results in similar, if not better, health outcomes compared to standard in-person care. For example, in their pre-pandemic survey-based evaluation of the telehealth program at Massachusetts General Hospital within five specialties (psychiatry, neurology, cardiology, oncology and primary care), Donelan et al. (2019) found that 73.8% of providers felt that they were able to see physical problems as well or better with a telehealth visit as with an in-person visit. Likewise, 85.2% of patients felt confident that a telehealth visit could take care of their health concerns. Based on those and other survey findings, Donelan et al. concluded that "for most encounters, these virtual visits are just as clinically effective and less expensive for both patient and provider compared with in-person visits." In their review of telehealth consultation within minority populations, Truong et al. (2022) also concluded that "telehealth-delivered interventions were mostly effective for the treatment/management of physical and mental health conditions including depression, diabetes, and hypertension."

With regard to hypertension, Yatabe et al. (2021) presented pre-pandemic evidence suggesting that patients receiving antihypertensive treatment "via home BP telemonitoring and web-based video visits achieve better BP control than conventional care." Taylor et al. (2022) echo those findings, in which they evaluated Doctor on Demand encounters for essential hypertension from March 2020 through February 2021 and found the telehealth intervention to be "broadly effective" with significant reductions in both systolic and diastolic blood pressure. They found that "most patients achieved a reduction of at least 5 mm Hg, with more than 48% of the patients achieving a reduction of at least 10 mm Hg in systolic blood pressure and 54.0% attaining a reduction of at least 5 mm Hg in diastolic blood pressure."

Diabetes care shows similar result for the impact of telehealth (Davis et al. 2020; Polonsky et al. 2020; De Groot et al. 2021; Aubert et al. 2022; Glennie, J.L., L. Berard, and F. Levrat-Guillen 2022~~; Lundström et al. 2022~~). De Groot et al. (2021) concluded from their review of the literature that "telemedicine is effective for improving HbA1c and thus glycemic control in patients with type 2 diabetes." In addition, they found other health outcomes and quality of life improved for those patients (De Groot et al. 2021). In their evaluation of adult type 2 diabetes patients younger than 75 years old at a single academic health center, Quinton et al. (2022) found that during the first nine months of the COVID-19 pandemic, those patients "utilizing telemedicine performed similarly on a composite measure of diabetes care quality compared to before the pandemic;" whereas "those not utilizing telemedicine had reductions" in quality of care.

In their evaluation of telehealth in the treatment of diabetes in the VA Health System, Aubert et al. reported that "despite a dramatic shift to virtual visits and a decrease in A1c measurement rates during the pandemic, we did not observe an effect on [type 2 diabetes] control or short-term [type 2 diabetes]related outcomes …" (Aubert et al. 2022). In their evaluation of the use of a remote glucose monitoring system in the management of type 2 diabetes, Glennie, J.L., L. Berard, and F. Levrat-Guillen (2022) reported significant reductions in HbA1c, which they attribute to the increased "opportunities for simultaneous review of glucose data with healthcare providers and shared decision-making [that encourages} adherence with treatment."

The effectiveness of telehealth also seems to hold true for mental health care (Quinton et al. 2022; Harerimana, B., C. Forchuk, and T. O'Regan 2019; de Albornoz, S.C., K. Siaa, and A. Harris 2022; Zhao et al. 2021). Bashshur et al. (2016) found telemental health to be well accepted by patients and highly effective across a comprehensive range of mental health diagnoses. A literature review by Harerimana et al. (2019) found that telemental care for depression in older adults also showed beneficial effects on depressive symptoms, emergency room visits and hospitalizations. In their literature review (pre-pandemic), de Albornoz et al. (2022) noted that "… consultations delivered by telephone and videoconference were as effective as face-to-face in-person visits to improve clinical outcomes in adults with mental health conditions and those attending primary care services." Finally, in their review of randomized controlled trials for the treatment of postpartum depression and anxiety in women, Zhao et al. (2021) found both symptoms to be significantly reduced with telehealth intervention compared with controls.

But the jury is still out for some areas of health care. Pekmezaris et al. (2019) compared telehealth self-monitoring to comprehensive outpatient management for underserved Black/African American and Hispanic heart failure patients and found that telehealth intervention was not effective either in improving quality of life or reducing hospitalizations. More recently, although Saloner et al. (2022) reported high continuity of treatment and high satisfaction among patients with opioid use disorder, Uhl et al. (2022) in their review of telehealth for the management of substance abuse disorders (SUD) conclude that although, "limited evidence suggests some benefit to adding telehealth to usual SUD care," the "evidence is very uncertain" that SUD outcomes for telehealth care are similar to usual care.

As a final example, in their randomized clinical trial of cognitive behavior therapy (CBT) delivered via the internet vs. face-to-face, Lundström et al. (2022) found that although both therapist-guided and unguided internet-delivered CBT demonstrated improvement in obsessive-compulsive symptoms, neither were as effective as face-to-face CBT. However, their health economics analysis found that both internet-delivered interventions were cost-effective compared with the face-to-face intervention, making those viable options when a therapist is not readily available for face-to-face treatment.

Those examples don't necessarily suggest that telehealth is ineffective for those conditions or populations. But they do remind that each application of telehealth must be evaluated to determine its own value. That being said, taken together, the published studies still paint a mostly favorable picture of telehealth's ability to have a positive impact on the second aim of the Quintuple Aim for Healthcare. Future analyses could study whether chronic care and ongoing mental health services are more effective with telehealth compared to a new patient evaluation. Additional studies determining whether the patient's role in sharing symptoms and relevant issues during a telehealth visit impacts the treatment would also be helpful.

A.3. AIM 3: REDUCED COST OF HEALTH CARE

There are two ways telehealth can contribute to reduced health care costs. The first is a short-term impact by directly influencing the costs of care. For example, it could literally cost less to provide the same services via telehealth vs. in-person care. Prior to the pandemic, that was often the case with payer reimbursement policies that favored in-person over telehealth care (Cutter, C., N.L. Berlin, and A.M. Fendrick 2020). Alternatively, telehealth could reduce the immediate health care costs because the convenience of it redirects patients from using higher-cost options such as emergency rooms (ERs) and urgent care centers.

The second way telehealth can contribute to reduced health care costs is longer term but potentially more impactful. Nurse practitioners, physician assistants and other personnel can help with monitoring better patient compliance and help reduce costs. When providers have an improved ability to monitor and communicate with their patients, particularly patients who are high risk or underserved, they will have a greater impact on their patients' health and will prevent avoidable adverse health outcomes such as hospitalizations with their associated costs (Kubes et al. 2021; Xu et al. 2022). Bowman et al. (2021) noted that undertreated chronic health conditions are a leading driver of health care costs. Therefore, "policies that encourage telehealth and remote patient monitoring can directly lead to improved chronic disease management, an area of underutilization and high cost to the health care system."(Bowman et al. 2021) Finally, telehealth also has the potential for being deployed in ways that can reduce health disparities and inequity. We discuss that aspect in Aim 5 below.

So, what does the research say about telehealth's ability to save health care costs? Data on avoided costs is promising. During the pre-pandemic period, researchers noted savings associated with telehealth care that were realized via avoiding unnecessary ER visits. For example, an analysis of ER visits in Rhode Island in 2013 and 2014 showed that 29%, 30% and 54% of Medicare, Medicaid and commercial ER visits, respectively, were preventable and resulted in an excess of $90 million in costs (State of Rhode Island Department of Health, n.d.).[95] Likewise, in 2015, Blue Cross Blue Shield of North Carolina estimated that 65% of ER visits weren't true emergencies and could have been treated by a primary care doctor within the next 12 hours (Blue Cross and Blue Shield of North Carolina, 2015). That implies there may be incremental patient behavioral change to be achieved that could potentially decrease the total cost of care.

Williams et al. (2021) found that Mississippi hospitals utilizing a telehealth emergency department network (TelEmergency) "had significantly lower annual [emergency department] costs compared with similarly matched hospitals that did not utilize TelEmergency." Likewise, according to a 2019 United Healthcare analysis, two-thirds of hospital emergency department (ED) visits annually by privately insured individuals in the U.S. are avoidable and could be treated safely and effectively in high-quality, low-cost primary care settings. That amounts to a savings opportunity of $32 billion each year (United Health Group 2019). Increasing patients' use of telehealth can significantly decrease that cost burden.

Kichloo et al. (2020) cited a 2019 study that JD Powers conducted, which estimated that a 1% decrease in ER visits due to telehealth could result in an annual savings of $101,920. Finally, in their evaluation of the use of telehealth in pre-hospital emergency medical services (EMS) over a 12-month period, Langabeer et al. (2017) found a 6.7% absolute reduction in potentially medically unnecessary ER visits resulting in a cost savings of $2,468 per ER visit. They concluded that using telehealth to evaluate and triage patients was cost-effective compared with traditional EMS "treat and transport to ED" model (Langabee et al. 2017).

But it's not only by avoiding unnecessary ER visits that telehealth can reduce health care costs. To the extent that telehealth care is comparable to in-person care in maintaining or improving health, one would expect to see lower (or at least no different) hospitalization rates. And there is evidence for that. For example, McLendon (2017) reported on the VA's telehealth program for veterans with diabetes and found an annual savings of $1,999 per patient, including a 38% reduction in hospital admissions and a 58% reduction in inpatient length of stay. Harerimana et al. (2019) evaluated telehealth for mental health care among older adults and found not only improved health outcomes such as reduced depressive symptoms and improved cognitive functioning but also lower health care utilization including reduced ER visits and hospital admissions. A pre-pandemic analysis of primary care telehealth visits in a large integrated health system by Reed et al. (2021) did not find differences in ER visits or hospitalizations compared to in-person clinic visits, suggesting that telehealth did not result in substandard care that would have led to increased costs. Finally, Kubes et al.'s (2021) mid-pandemic EMR and claims-based health care utilization analysis for a large health care system found lower 30-day hospitalization rates for telemedicine appointments compared to in-person appointments.

In some cases, of course, telehealth might enable patients to avoid certain primary or specialist visits along with their associated costs as, for example, in teledermatology, teleopthamology, telemamography or teledentistry (Bertrand, S.E., M.A. Weinstock, and S.M. Landow 2019; Curran et al. 2022; Leader et al. 2006; United Health Group 2022).

But what about the concern that telehealth will lead to increased downstream health care visits? Here the findings have been mixed. For example, Li et al. (2021) compared pre-pandemic telehealth visits for acute respiratory infections to in-person visits and found that the telehealth cohort had a greater number of subsequent office, urgent care and telemedicine visits. That would suggest that switching care to telehealth delivery might result in initial savings being offset by downstream utilization costs.

Reed et al. (2021) also noted a significant difference in follow-up visit rates for telehealth visits for upper respiratory infections and skin disorders, but there was only a slight difference in total follow-up visit rates for telehealth vs. in-person visits. Similarly, Liu et al.'s (2021) pre-pandemic claims-based analysis for Blue Cross Blue Shield of Michigan found that telehealth visits were associated with additional episodes of care within 30 days compared with in-person visits. Finally, Li et al.'s (2022) claims-based analysis of 4,038 primary care practices in Michigan between

January 2019 and September 2020 found that practices with higher telehealth use had slightly higher visit rates compared with practices with lower telehealth use.

On the other hand, Gujral et al.'s (2021) analysis of the VA telehealth program, V-IMPACT, found that adoption of the program resulted in a significant increase in telehealth visits but not an increase in overall primary care or mental health care. That suggests that telehealth visits were substituting for in-person care, not adding to it. Overall, they found it to be cost-neutral (Gujral et al. 2021). Nord et al. (2019) noted savings to both patients and payers in terms of reduced costs from avoided ER visits without additional downstream care costs. And Kalwani et al. (2022) found that within the cardiology department within an academic health care center, the high rate of telehealth use during the pandemic did not result in an increase in the number of visits per patient. Taken together, those studies suggest the advisability of continuing to watch the relationship of telehealth use with downstream care use.

Overall, the balance of research thus far seems to support telehealth's ability to advance the quintuple aim's goal of reducing health care costs. However, much of that will depend on the degree to which it also addresses the aim of improved health. That impact is likely to vary widely across populations. Telehealth is likely to have its greatest impact on higher-risk and underserved populations. Within lower risk populations, the resources used to deliver telehealth will likely determine whether it results in lower health care costs. We discuss that further in the final section of this appendix.

A.4. AIM 4: IMPROVED PROVIDER EXPERIENCE

According to HealthStream (2021), "U.S. healthcare organizations are plagued by staff dissatisfaction, burnout, staff disconnection with leadership, and care providers who suffer from a loss of meaning in their work." Provider burnout has become a serious issue threatening the health care system. The goal for Aim 4 of the quintuple aim is to improve the provider experience by giving providers access to tools and resources that can reduce their burden and enable them to operate at the top of their training. That will reduce the likelihood of burnout while improving the quality of the health care they provide.

A survey that RAND Corporation conducted in 2014 on behalf of the American Medical Association found six sources of dissatisfaction among providers (Friedberg et al. 2014). Telehealth has the potential for addressing several of those by improving workflows, reducing unnecessary administrative tasks, improving work/life balance, and enhancing providers' ability to stay connected with and provide more effective care for their patients. Regarding that last point, Jetty et al. (2021) estimated that 42% of the total visits to primary care physicians were amenable to telehealth and 73% of the total services rendered could be delivered through telehealth modalities.

All of that, of course, is predicated on the appropriate integration of telehealth services into traditional health care practices. That process was pushed into high gear during the pandemic's early phase. As a result, in addition to demonstrating the health care system's ability to rapidly adapt to enable increased telehealth utilization, there also have been lessons learned. We focus on those in Section B, The Future: Telehealth Integration.

Telehealth's success for improving the provider experience in delivering health care is reflected in measures of satisfaction that have been taken pre- and post-peak COVID-19. Overall satisfaction with telehealth both pre- and post-pandemic has been very good (Volcy et al. 2021; Nguyen, M., et al. 2020; Connor et al. 2021; Gentry et al. 2021; Neeman et al. 2021; Saiyed, S., A. Nguyen, and R. Singh 2021; Uscher-Pines et al. 2022; Vosburg, R.W., and K.A. Robinson 2022). Besides having a generally positive view of telehealth, providers also expect to continue using it after the pandemic has subsided (Mehak, N., and R. Sharma 2021; Sallam et al. 2021; Bunnell et al. 2020; Nies et al. 2021). Those positive findings probably reflect several factors including providers' and patients' increased familiarity with telehealth; a supportive infrastructure that was put in place by necessity during the pandemic; improvements in patient no-show rates (Drerup, B., J. Espenschied, J. Wiedemer, and L. Hamilton 2021; Franciosi et al. 2021; Sugarman et al. 2021); improved workflow and work/life balance (Goldberg et al. 2022; Donelan et al. 2019; Bhargava et al. 2021; DeHart et al. 2021; Malouff et al. 2021); and providers' recognition that they can provide a substantial portion of care via telehealth without sacrificing quality of care (Neeman et al. 2021; Malouff et al. 2021; Thomson, A.J., et al. 2021).

Providers also reported concerns about telehealth. While they acknowledged that telehealth can be an acceptable alternative to in-person care in many instances, it is also clear that they will need to exercise clinician judgment. For example, Singh et al. (2022) report that while rheumatology providers in the VA were comfortable with using telehealth for existing patients, they were less comfortable with that modality for new patients. Issues of telehealth technology, including quality of video and broadband access for both providers and their patients, tend to head the list of problems that providers reported (Sugarman et al. 2021, Thomson, A.J., et al. 2021; Lee, M., et al., n.d.).

Telehealth technology also has the potential to negatively impact providers' experience with delivering health care. For example, Sugarman et al. (2021) reported the potential problem of "Zoom fatigue" resulting not only from an excess of video consultations but also from the fact that mental health providers found it to be more physically and emotionally taxing than in-person visits. However, that may also prove to be a problem for other types of providers. Telehealth training can address some of the issues for providers and their patients, an issue reported by Thomson, A.J., et al. (2021), among others.

Note that not all providers shared the same enthusiasm with continuing telehealth visits post-pandemic. For example, Hunsinger et al. (2021) found that only 16.7% of mental health providers and 25% of their patients would prefer to continue telehealth visits post-pandemic. Finally, there are also issues relating to telehealth reimbursement that threaten to make telehealth less attractive to providers (Goldberg et al. 2022); but we will discuss those in Section B, The Future: Telehealth Integration.

A.5. AIM 5: IMPROVED HEALTH EQUITY

The pandemic served to accelerate the availability of telehealth-based health care within underserved populations, including populations in rural and remote areas. It forced health care providers to develop infrastructure, workflows and procedures to deliver care remotely, and the relaxation of policies restricting the use of telehealth facilitated its growth (Bowman, C.A., M. Nuh, and A. Rahim 2021). The ability to better reach underserved populations was always seen as a benefit for telehealth, and the experience of providing telehealth care during the pandemic to such populations has shown promise (Truong et al. 2022; Yilmaz et al. 2019). But it also revealed barriers that we must overcome if telehealth is to fulfill its promise of helping the health care system achieve equitable health care delivery.

In fact, the greatest challenge for telehealth remains the health care systems' ability to deliver it equitably across populations traditionally at risk for health disparities. Those include patient demographics such as race (nonwhite), socioeconomic status (lower income; homeless), geographic region (rural/remote) and age (elderly). Those are also the groups that tend to have less access to computers, smartphones and internet bandwidth, and they also tend to be less digitally literate. So, it is not surprising that many studies during the pandemic found that telehealth continues to underserve those populations — those who could benefit most (Cantor et al. 2021; Katz et al. 2022; Uscher-Pines 2022; Cao et al. 2021; Drake et al. 2022; Jewett et al. 2022; Qian et al. 2022). Still, not all studies report disparities in telehealth utilization. For example, in their review of outpatient visits for the Beth Israel Deaconess Health System during the pandemic's early phase, Stevens et al. (2021) found that the health system's implementation of telehealth did not result in an exacerbation of inequity in health care access. They also found that older patients were more, not less, likely to use telehealth, although their use was more likely to be audio rather than video. However, that was early in the pandemic and is a finding that might not replicate. In addition, Stevens et al. did not evaluate geographic factors (e.g., urban vs. rural) where differences in access may still be present. Along with Stevens et al., it is probably best to exercise caution and continue to monitor potential indications of health inequities. The solutions for improving health equity will likely come from several sources; among them, telehealth policy adjustments and finding ways to increase broadband and mobile access to the underserved will likely be highest on the list (Karimi et al. 2022).

B. THE FUTURE: TELEHEALTH INTEGRATION

Telehealth utilization was already growing prior to the COVID-19 pandemic, thanks to the successes demonstrated by remote patient monitoring technology for selected high-risk health conditions as well as the efforts of early adopters such as the VA, Kaiser-Permanente and the Mayo Clinics. Nevertheless, its use was still minimal prior to

2020. The pandemic pushed telehealth into the mainstream of health care service delivery. Now that the country is moving closer to an endemic status with respect to COVID-19, the question becomes what telehealth's appropriate status is going forward. In general, the consensus in recent literature is not only that telehealth is here to stay but that it will also become increasingly integrated into the total spectrum of health care provided to most patients. The initial surge in telehealth utilization levels occasioned by the need to protect patients, staff and an overburdened hospital network stabilized quickly at significantly lower levels, though still higher than pre-pandemic levels. Now that the urgency for telehealth has mostly dissipated, the challenge remains how to effectively integrate telehealth services across the wide variety of clinic settings (Balut et al. 2022; Beneteau, E., A. Paradiso, and W. Pratt 2022). Several factors will likely drive that continued integration, and each of those factors raises challenges that the health care system will have to meet to ensure optimal results.

MAIN DRIVERS OF FUTURE TELEHEALTH GROWTH:

<u>Telehealth access policies and reimbursement parity.</u> For telehealth to effectively be integrated into post-pandemic standard health care, there will need to be statutory guidelines regulating its use. Just as the relaxation of policies related to telehealth access, cross-state medical licensure, HIPAA regulations and reimbursement parity allowed telehealth utilization to expand rapidly, reinstatement of such restrictions will likely be the most important deciding factor either supporting or limiting telehealth's continued growth (Goldberg et al. 2022; Drake et al. 2022; Brotman, J.J., and R.M. Kotloff 2021; Mehrotra, A., R.S. Bhatia, and C.L. Snoswell 2021; Wahezi et al. 2021; Kimball, A.B. 2022).

Determining the right policies to regulate telehealth fairly across the nation will also be a complex process. Ideally those guidelines would be based on evidence-based, best practices within and across medical service types, but it will take time for such research-based guidance to be available. Therefore, lawmakers will need to make their choices based on the experiences gained thus far out of the natural experiment that the COVID-19 pandemic provided. The federal government is already considering a number of different bills seeking to regulate telehealth (Bailey, V. 2021a.; Bailey, V. 2021b; Wicklund, E. 2021; Melchionna, M. 2022; Vaidya, A. 2022a; Vaidya, A. 2022b), and states have already begun to pass such legislation (Vaidya, A. 2022c). Information on current telehealth policies and legislation can be found at the Center for Connected Healthcare Policy website (Center for Connected Health Policy). Archambault et al. (2022) have also provided a tool for rating states on telehealth best practices. However, as policies and payment regulations continue to evolve, the inherent uncertainty may cause providers to hesitate becoming fully engaged in utilizing telehealth with their patients (Mehrotra, A., R.S. Bhatia, and C.L. Snoswell 2021).

<u>Provider Experience.</u> As Wahezi et al. (2021) noted, "The future of telemedicine will depend on the willingness of clinicians to participate in telemedicine encounters and patient demand for this product." As discussed earlier, despite the need for the rapid replacement of many in-person visits with telehealth visits, most providers have had a positive experience with this modality for delivering health care. Their experience increased their familiarity with the potential for telehealth with the context of their day-to-day practice of health care. And as also mentioned, many patient visits and health care services are amenable to telehealth (Jetty et al. 2021). In addition, providers noted that patient outcomes did not appear to suffer. While that does not mean that all such visits should be switched to telehealth, it does encourage providers to deliver health care that can be more patient-centered. A recent McKinsey Physician Survey found that doctors recognize that telehealth is more convenient for their patients even though it may not necessarily be more convenient for them (Cordina et al. 2022).

Provider experiences with telehealth during the pandemic also revealed a number of issues that will require resolution. Many of those are technological, involving broadband access and computer skills for troubleshooting videoconference problems, while others have been practical such as the lack of a physical examination and the accurate measurement of vital signs (Jacobs et al. 2022; Kalwani et al. 2022; Mehak, N., and R. Sharma 2021).

With regard to the measurement of vital signs, theoretically, it is possible for patients to use existing validated devices in their homes and upload that data to their providers. That is how remote patient monitoring has always operated. For example, during the height of the COVID-19 pandemic, both Michaud et al. (2021) and Kagiyama et al.

(2021) demonstrated the feasibility of that approach. However, the cost of doing that across all patients, not just those with medical conditions or those at high risk, is prohibitive.

There is obviously a need for lower-cost multifunction vital signs measurement devices, and, in fact, a number of those already exist. But, there is still concern over the validity of vital sign measures obtained via such devices. For example, Hahnen et al. (2020) studied the accuracy of vital signs measurements by two novel all-in-one physiological monitoring devices — the Everlast TR10 smartwatch and the BodiMetrics Performance Monitor medical tricorder. They found the smartwatch not accurate enough to be used as a vital signs measurement device. And while they found the tricorder to be more accurate, it still failed to meet their predetermined accuracy standards for both systolic blood pressure and oxygen saturation (McConnochie, K.M. 2019).

But there is still a need for such multifunction vital signs measurement, and technology will continue to improve. For example, Pintavirooj et al. (2021) reported on their development of a relatively low-cost Wi-Fi-based device designed to be used in a patient's home that can simultaneously and without delay monitor six vital signs — electrocardiogram, heart rate, plethysmogram, percent saturation oxygen, blood pressure and body temperature (Bashshur et al. 2020). There are still barriers to the practical use of such devices, such as Wi-Fi availability and the need to calibrate the blood pressure monitor to match office-based measurements. And there is still the matter of cost that may still make it unavailable to many of the underserved who might benefit most from it. However, those problems also can and will eventually be solved.

Some providers are concerned about telehealth related to job demands. For example, if not integrated effectively, telehealth can actually place additional administrative burdens on providers who are already experiencing burnout (Sugarman et al. 2021). Telehealth requires adjustments in support staff and workflows to prevent that (Uscher-Pines et al. 2022; Parthasarathy, M, J. Khuntia, and R. Stacey 2021). The telehealth experience during the early phase of the pandemic also pointed out deficiencies in provider and support staff training in how to effectively use telehealth not just logistically but also in terms of establishing and maintaining a working relationship between providers and patients, something called "website manner" (Ghaddar et al. 2020; Morgan et al. 2022). Finally, in the enthusiasm to increase the use of telehealth, note that not all providers are in a position to benefit equally. Small practices and those in rural environments with less access to broadband and other resources may suffer loss of revenues to those more able to meet patient demand for telehealth (Vaidya, A. 2022d; Budhwani et al. 2022). Therefore, caution is warranted as the system moves forward with an expanded use of telehealth.

Provider opinions about post-pandemic telehealth use are mixed. For example, some surveys show strong preferences of both providers and their patients for the continued use of telehealth post-pandemic (Mehak, N., and R. Sharma 2021). However, without the pressure of a pandemic, many providers still prefer returning to in-person visits even though their experience with telehealth may have been generally positive (Cordina et al. 2022). That is not unlike the situation with patients where a similar mixture of seemingly contradictory opinions has been shown to coexist. In any case, the net impact of those experiences will likely result in a negative influence on telehealth's growth. That is not necessarily a bad outcome. There needs to be time for research to help sort out the conditions where telehealth provides the most beneficial impact, and providers will need guidance on best practices for telehealth within their specialty. Providers understand that the best use of telehealth will be not as a replacement for in-person care but as an enhancement to their ability to provide quality health care to a greater percentage of patients by individually tailoring care to their patients' needs (Balut et al. 2022; Beneteau, E., A. Paradiso, and W. Pratt 2022; Drake et al. 2021; Jewett et al. 2022).

Patient Experience. Like any other industry, health care is also driven by patient demand and satisfaction, which will influence both providers and payers. On the one hand, providers want to decrease barriers to delivering effective health care to their patients, and telehealth represents a major way for providers to do that. On the other hand, payers also want the members they service to give them positive ratings, which help them compete in the marketplace and, in the case, for example, with Star ratings for Medicare, may improve the level at which they are reimbursed.

Patients, in general, had a positive experience with telehealth during the pandemic. For example, according to a survey that Doximity (2022) conducted, over 73% of patients surveyed reported that they planned to receive either some or all of their care through telemedicine after the pandemic. Much of that has to do with the way telehealth can reduce patient burdens of receiving health care, particularly in rural communities and among those who have personal or job-related challenges to participating in in-person care. It is also related to the fact that the pandemic "broke the ice" with respect to patients receiving telehealth-based health care. Before the pandemic, a large percentage of patients were not even aware of telehealth, even when it was available (Lieu et al. 2022). Providers who are able to provide telehealth services seamlessly and effectively and payers who support the use of telehealth likely will find patient/member satisfaction ratings improving.

There are significant challenges that remain for all patients to have a positive experience with telehealth and for telehealth care to be equitable. Many of those challenges again involve technology (Saiyed, S., A. Nguyen, and R. Singh 2021). For example, while most Americans have smartphones (Kolmar, C. 2022), many still do not have adequate broadband service or phone connectivity to enable effective videoconferencing with their health care providers (Hsueh et al. 2021). While recently passed legislation should help remedy that situation, it will still take time before such access has been expanded. In the meantime, a solution that health care systems are exploring is to set up telehealth hubs and external sites where patients with limited technology access can go for virtual visits (Payan et al. 2022).

A second challenge to universal utilization of telehealth is the digital divide (Qian et al. 2022; Stevens et al. 2021; Karimi et al. 2022; Beneteau, E., A. Paradiso, and W. Pratt 2022; Brotman, J.J., and R.M. Kotloff 2021; Mehrotra, A., R.S. Bhatia, and C.L. Snoswell 2021; Wahezi et al. 2021; Kimball A.B. 2022; Bailey, V. 2021a; Bailey, V. 2021b; Wicklund E. 2021; Melchionna M. 2022; Vaidya, A. 2022a; Vaidya, A. 2022b; Vaidya, A. 2022c; Center for Connected Health Policy; Archambault, J., and V. Nastasi 2022; Cordina et al. 2022; ECRI, n.d.; Chua, I.S., V. Jackson, and M. Kamdar 2020; McConnochie, K.M. 2019; Bashshur et al. 2020; Parthasarathy, M, J. Khuntia, and R. Stacey 2021; Ghaddar et al. 2020; Morgan et al. 2022; Vaidya, A. 2022d; Budwani et al. 2022; Lieu et al. 2022; Hsueh et al. 2021; Payan et al. 2022; Mahtta et al. 2021). Patients who are less comfortable with digital technology will be less willing to request or use it (Uscher-Pines et al. 2022). Lieu et al. (2022) noted that patients of low socioeconomic status, those with low English proficiency, and Black/African American or Hispanic/Latino patients are more likely to have trouble using video visits. That is at least partially due to their lower level of digital literacy. That will require training and support, something new for providers, but it is an area where payers perhaps could help. For example, health care systems like Kaiser-Permanente are experimenting with using medical assistants to help digitally challenged patients with "virtual rooming" to help them have a successful video connection with their health care provider (Lieu et al. 2022).

Although it does not appear to be a major issue among patients, privacy and confidentiality concerns still remain along with concerns about the risk of data loss or hacking (De Biase et al. 2020). During the pandemic, CMS eased telehealth restrictions and allowed the use of non-HIPPA-compliant applications (such as FaceTime and WhatsApp). However, it is still strongly recommended that providers use a HIPPA-compliant software to perform telemedicine encounters. That requirement, while not insurmountable, might slow telehealth growth in the post-pandemic era.

Finally, there are also issues of language proficiency (Franciosi et al. 2021; Uscher-Pines et al. 2022; Hakkennes, S., and P. Singh. 2020). As Payan et al. (2022) noted, having personnel who are bilingual and who can provide language concordant care will be essential for efficient and high-quality patient telehealth experiences (Bestsennyy, O., G. Gilbert, A. Harris, and J. Rost 2021).

<u>Payer Competition.</u> Telehealth addresses several payer needs, including the ability to reach underserved populations and address provider shortages. It also has the potential to deliver improved health outcomes, which is the objective of value-based provider incentives. Therefore, when telehealth is appropriately integrated into a comprehensive health care system, it has the potential to reduce some short- and long-term health care costs. In the future, payers who support provider networks in delivering telehealth services to the populations they serve will be better able to compete in the marketplace (Doximity, n.d.).

However, payers are understandably cautious about embracing telehealth too quickly or too universally. One concern was that increased telehealth availability would lead to overuse (Roland, J., D. Potter, and E. Caplan 2022). The convenience of improved health care access would encourage patients to engage in unnecessary provider contacts in a way similar to overuse of Eds and urgent care facilities. Before the pandemic, that was not a major issue because restrictive telehealth access and reimbursement policies served to prevent overuse. In fact, those policies were the main limiting factor to the growth of telehealth in the pre-pandemic period (Cutter, C., N.L. Berlin, and A.M. Fendrick 2020). The pandemic, of course, changed all of that when restrictive access policies were suspended and reimbursement parity was established. During the pandemic, that facilitated the utilization of telehealth services, but, as noted in an earlier section of this literature review, it has not resulted in significant increases in the total number of visits.

A second concern is that expanded availability for telehealth could lead to fraud. There has already been evidence, which new legislation is seeking to address (Bailey, V. 2021a; Greiwe, J. 2022). Obviously fraud and abuse are real and in need of correction (Cutter, C., N.L. Berlin, and A.M. Fendrick 2020). On the other hand, this concern falls short as an argument against telehealth expansion. The vice president for public policy of the American Telehealth Association, Kyle Zebley has noted, “telehealth is no more prone to fraud, waste, and abuse than in-person care. Telehealth even includes a digital trail that helps ensure accountability for reimbursement” (Payan et al. 2022).

Another concern is that health outcomes might be substandard compared with the same in-person care (Uscher-Pines et al. 2022). While limited uses of telehealth, such as remote patient monitoring for patients with certain chronic health conditions, were associated with improved health outcomes leading to lower expectations for health care costs, widespread use of telehealth was untested, leaving its value largely unknown (Lo et al. 2022a; Lo et al. 2022b). A related issue is that replacing in-person care with telehealth care would lead to additional downstream health care visits due to health issues not being adequately addressed (Liu et al. 2021). Those extra visits would cancel out and might exceed the costs saved via a telehealth visit. And if telehealth care is substandard, it could result in avoidable downstream health consequences and costs if, for example, an important diagnosis is missed. It is too soon to tell whether that concern is valid, but it emphasizes the need to continue evaluating the conditions under which telehealth is most effective.

Continuously improving technology. Health care is increasingly technology driven. And competition within the telehealth industry will drive its growth (Palmer, A., and B. Coombs. 2022; Park, S., B.A. Langellier, and D.J. Meyers 2022; Persaud, Y.K. 2022). Rapid improvements in medical devices, apps, electronic health records and communication platforms will give providers the tools they need to take better advantage of telehealth as a modality for delivering quality health care. Essentially, telehealth will become more appropriate as an option for an increasing number of patient groups and health care services. In addition, newer players such as Amazon and Walmart by virtue of their superior technology will act as disruptors, forcing the traditional health care system to adapt in its ability to provide quality telehealth access (Barber et al. 2022).

Documented results. Telehealth performed well at a time when it was critically needed to provide continuity in health care during the COVID-19 pandemic. So far, it appears that health outcomes were not adversely affected, but that needs further verification. Obviously, further appropriately designed research is needed to clarify factors defining the effective use of telehealth within the context of total healthcare delivery (Wahezi et al. 2020). Patient outcomes should ultimately drive the speed and extent of telehealth’s expansion in nonpandemic conditions. Additional research is needed to show how best to integrate telehealth within each medical and behavioral specialty area, including — most importantly — primary care. Ideally, each health care discipline, including primary care, will develop and continue to refine guidelines for the evidence-based use of telehealth within their specialty — see Barber et al. (2022) for an example. Those guidelines will be based on research documenting the beneficial use of telehealth across populations served. However, as that research becomes available, it will be important to avoid the misconception that telehealth needs to achieve outcomes that are superior to in-person care for it to be recommended. Noninferiority in health-related outcomes is equally acceptable. It allows other health care system aims, such as convenience for the patient and provider, to drive the choice.

Appendix 3: Literature Review — Telehealth Utilization Patterns Pre- to Post-Peak COVID-19

Reference	Population	Telehealth Utilization (TU)
Alexander et al. 2020	The National Disease and Therapeutic Index: a nationally representative audit of outpatient practice in the U.S.	There was more than an eightfold increase in the percent of primary care visits compared with pre-pandemic (2018-Q1 2019) levels.
Balut et al. 2022	Large California VA Medical Center, cardiology outpatient clinics	There was a twelvefold increase in telehealth use in March 2020 compared with pre-COVID-19 period; TU continued to increase through June 2020, after which it declined somewhat but still remained significantly higher than the pre-COVID-19 period.
Cantor et al. 2021	Employer-based health plan beneficiaries	There was more than a twentyfold increase in TU compared with 2019; rate for metropolitan population.
Choi et al. 2022	Medicare beneficiaries aged 65-plus; National Health and Aging Trend Study Round 10	There was a nearly fivefold increase in self-reported telehealth use during COVID-19 period compared with pre-COVID-19.
De Biase et al. 2020	Neurosurgical practices, Mayo Clinic	There was a 6.25-fold increase in telehealth visits April 2020 vs. March 2020 (from 4% of all visits to 25% of all visits).
Friedman et al. 2022	Independence Blue Cross beneficiaries	Compared to the pre-pandemic period (pre-March 11, 2020), telehealth claims increased dramatically from an average of 773 weekly telehealth visits to a high nearing 80,000 visits during April 2020, then falling to near 40,000 visits per week by October 2020. There was nearly a sixtyfold increase in telehealth visits during the pandemic period compared with the pre-pandemic period.
Gilson et al. 2020	University of Chicago ambulatory practice sites	Telehealth visits increased from 0 to 48,475 visits between March 15 to May 31, 2020, and comprised 60.5% of total visit volume.
Hamadi et al. 2021	Mayo Health Clinic visits	Virtual visits at Mayo Clinic went from 4% (pre-pandemic) to 85% (at the peak of the pandemic) and subsequently fell to approximately 10%-15% of visits being virtual.

Hertzer and Pronovost 2021	Privately insured individuals (FairHealth)	There was an eighty-six-fold increase in the percentage of claims associated with telehealth April 2020 vs. April 2019 (13% vs, 0.15%).
Jacobs et al. 2022	VA Medical Centers, nationwide	Compared to the pre-COVID-19 period (Jan. 1, 2020, to March 10, 2020), there was fivefold to tenfold increase in telehealth use across 139 VA Medical Centers during the early COVID-19 period (March 11, 2022, to May 20, 2022).
Kalwani et al. 2022	Multispecialty cardiovascular center in Northern California	Telehealth use for new patients increased from 3.5% of visits during the pre-COVID-19 period (March 2019 to February 2020) to 63.0% during the COVID-19 period (March 2020 to February 2021), an eighteenfold increase. There was an initial spike of 76% of visits in April 2020, which declined to 45% by July 2020, then rebounded to 60% by February 2021. The pattern was similar for return patient visits.
Katz et al. 2022	Medicare Advantage and Commercial health plan members; HealthCore Integrated Research Database; newly diagnosed cancer patients	The percentage of patients with a telehelalth visit rose from a pre-COVID-19 (pre-March 2020) level of 0.4% to a high of nearly 60% by April 2020, then falling to just over 20% by August 2020.
Knierim et al. 2021	University-based primary healthcare	There was a fifty-two-fold increase in telehealth visits during the first five months of the pandemic (March-July 2020) vs. the preceding five months; 73% of all visits were virtual in April 2020, falling to 28% by July 2020.
Koonin et al. 2020	Four of the largest U.S. telehealth providers that offer services in all U.S. states	There was a 154% increase in telehealth visits during the last week of March 2020, compared with the same period in 2019.
Lo et al. (2022a)	Outpatient visits for patients from over 156 Epic organizations	Pre-COVID-19 (March 2019 to February 2020) telehealth visit levels were near 0%. During March 2020 to August 2020, that rose to 13% and subsequently fell to 8% during March to August 2021.
Lo et al. (2022b)	Mental health/substance use visits for patients from over 156 Epic organizations	Pre-COVID-19 (September 2019 to February 2020) telehealth visit levels were 9%. During March 2020 to August 2020, that rose to 24% and continued to rise to 39% during March to August 2021.
Mann et al. 2020	Large health system (New York University Langone Health)	There was a 683% increase in telehealth visits between March and April 2020.

Patel et al. 2021	OptumLabs Data Warehouse: national sample of 16.7 million individuals with commercial or Medicare Advantage insurance	There was a twenty-two-fold increase in telehealth visits from January through mid-June 2020; telehealth visits increased from 0.8 visits/1,000 (0.8%) in January to a peak of 30.7 visits/1,000 (43.2%) in April, then fell to 17.8 visits/1,000 (18.9%) in mid-June.
Samson et al. 2021	Medicare Fee-for-Service beneficiaries	There was a sixty-three-fold increase in Medicare Part B telehealth visits in CY 2020 (5.3% of total visits) vs. CY 2019 (0.1% of total visits).
Uscher-Pines et al. 2021	California Safety-Net Organizations	Prior to April 2020, telehealth use was essentially zero; during the pandemic period studied (April-August 2020), primary care telehealth use (telephonic and video) increased to 51.9% of total visits.
Vogt et al. 2022	Patients from a large clinical research hospital; Doxy.me utilizers	There was a twenty-ninefold increase in telehealth utilization (monthly minutes) for the COVID-19 period (March-November 2020) compared with pre-COVID-19 levels (January-February 2020).
Xu et al. 2021	Members from a large integrated health care system (Kaiser-Permanente Southern California)	There was a fourfold increase in the telehealth visit rate during the early days of the pandemic year (Week 8 vs. Week 12), which decreased to a threefold increase by Week 43.

Appendix 4: Overall Population by Gender by Year by LOB

OVERALL COMMERCIAL POPULATION BY GENDER BY YEAR

Unique member by Gender			
	2019	2020	2021
F	10,297,115	9,431,260	9,219,158
M	10,408,665	9,507,606	9,320,551
Grand Total	**20,705,780**	**18,938,780**	**18,539,709**

OVERALL MEDICARE POPULATION BY GENDER BY YEAR

Unique member by Gender			
	2019	2020	2021
F	3,042,593	3,334,115	3,864,713
M	2,254,479	2,495,670	2,927,862
Grand Total	**5,297,072**	**5,829,785**	**6,792,575**

Appendix 5: Telehealth Service Identification Criteria

Field Name	Values
Provider Specialty	VIRTUAL VISITS TELEHEALTH MED
Revenue Code	0780
Place of Service Code	02
Row	29
Procedure Modifier Code	95, GT, GQ, G0
Procedure Code	98966, 98967, 98968, 98970, 98971, 98972, 99091, 99421, 99422, 99423, 99441, 99442, 99443, 99446, 99447, 99448, 99449, 99450, 99451, 99452, 99453, 99454, 99457, 99458, 99473, 99474, G0406, G0407, G0408, G0425, G0426, G0427, G0459, G0508, G0509, G2010, G2012, G2061, G2062, G2063, S9110, T1014

Appendix 6: CMS Eligible Telehealth Codes

Field Name	Values
Procedure Category	Procedure Codes
CMS-EM	99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, 99215, 99217, 99218, 99219, 99220, 99221, 99222, 99223, 99224, 99225, 99226, 99231, 99232, 99233, 99234, 99235, 99236, 99238, 99239, 99262, 99263, 99281, 99282, 99283, 99284, 99285, 99291, 99292, 99293, 99294, 99295, 99296, 99297, 99299, 99300, 99303, 99304, 99305, 99306, 99307, 99308, 99309, 99310, 99312, 99315, 99316, 99323, 99324, 99325, 99326, 99327, 99328, 99333, 99334, 99335, 99336, 99337, 99341, 99342, 99343, 99344, 99345, 99347, 99348, 99349, 99350, 99351, 99353, 99354, 99355, 99356, 99357, 99372, 99373, 99406, 99407, 99441, 99442, 99443, 99468, 99469, 99471, 99472, 99473, 99475, 99476, 99477, 99478, 99479, 99480, 99483, 99495, 99496, 99497, 99498, G0376, G0436, G0437
CMS-MHSA	90785, 90791, 90792, 90801, 90804, 90805, 90806, 90807, 90808, 90813, 90817, 90827, 90832, 90833, 90834, 90836, 90837, 90838, 90839, 90840, 90843, 90844, 90845, 90846, 90847, 90853, 90857, 90875, G0072, G0396, G0397, G0410, G2086, G2087, G2088
CMS-TELEHEALTH	G0406, G0407, G0408, G0425, G0426, G0427, G0459, G0508, G0509
CMS-OTHER	63690, 77427, 90830, 90901, 90902, 90951, 90952, 90953, 90954, 90955, 90956, 90957, 90958, 90959, 90960, 90961, 90962, 90963, 90964, 90965, 90966, 90967, 90968, 90969, 90970, 90995, 92002, 92004, 92012, 92014, 92330, 92506, 92507, 92508, 92521, 92522, 92523, 92524, 92525, 92526, 92550, 92552, 92553, 92555, 92556, 92557, 92563, 92565, 92567, 92568, 92570, 92587, 92588, 92601, 92602, 92603, 92604, 92607, 92608, 92609, 92610, 92625, 92626, 92627, 93750, 93797, 93798, 94002, 94003, 94004, 94005, 94625, 94626, 94664, 95831, 95832, 95833, 95834, 95881, 95970, 95971, 95972, 95978, 95979, 95983, 95984, 96100, 96101, 96102, 96105, 96110, 96111, 96112, 96113, 96115, 96116, 96118, 96119, 96121, 96125, 96127, 96130, 96131, 96132, 96133, 96136, 96137, 96138, 96139, 96150, 96151, 96152, 96153, 96154, 96155, 96156, 96158, 96159, 96160, 96161, 96164, 96165, 96167, 96168, 96170, 96171, 97001, 97002, 97003, 97004, 97100, 97110, 97112, 97114, 97116, 97127, 97129, 97130, 97145, 97150, 97151, 97152, 97153, 97154, 97155, 97156, 97157, 97158, 97161, 97162, 97163, 97164, 97165, 97166, 97167, 97168, 97530, 97532, 97535, 97537, 97542, 97750, 97755, 97760, 97761, 97762, 97763, 97802, 97803, 97804, 98960, 98961, 98962, 99420, 0359T, 0360T, 0361T, 0362T, 0363T, 0364T, 0365T, 0366T, 0367T, 0368T, 0369T, 0370T, 0371T, 0372T, 0373T, 0374T, G0108, G0109, G0200, G0270, G0296, G0420, G0421, G0422, G0423, G0438, G0439, G0442, G0443, G0444, G0445, G0446, G0447, G0506, G0513, G0514, G2211, G2212, G9685, S9152

Appendix 7: Claim Groups

Ranking	Procedure Category	Place of Service Category	Provider Type	Claim Group
100	CMS-MHSA	HOME	MHSA	HOME
101	CMS-EM	HOME	MHSA	HOME
102	CMS-OTHER	HOME	MHSA	HOME
103	CMS-TELEHEALTH	HOME	MHSA	HOME
104	CMS-MHSA	HOME		HOME
105	CMS-EM	HOME		HOME
106	CMS-OTHER	HOME		HOME
107	CMS-TELEHEALTH	HOME		HOME
108	CMS-MHSA	OFFICE/TH	MHSA	MHSA
109	CMS-MHSA	OFFICE/TH		MHSA
110	CMS-EM	OFFICE/TH	MHSA	MHSA
111	CMS-OTHER	OFFICE/TH	MHSA	OTHER
112	CMS-TELEHEALTH	OFFICE/TH	MHSA	OTHER
113	CMS-EM	OFFICE/TH		E&M
114	CMS-OTHER	OFFICE/TH		OTHER
115	CMS-TELEHEALTH	OFFICE/TH		OTHER

Appendix 8: Procedure Grouping for Coding and Documentation

Category	Procedure Code(s)
CMS-ADV-CARE	99497, 99498
CMS-AUDIOLOGY	92550, 92552, 92553, 92555, 92556, 92557, 92563, 92565, 92567, 92568, 92570, 92587, 92588
CMS-BEHAVIORAL	96150, 96151, 96152, 96153, 96154, 96155, 96156, 96158, 96159, 96160, 96161, 96164, 96165, 96167, 96168, 96170, 96171, 99420
CMS-BEHAVIOR-ASSESSMENT	0362T, 0363T, 0373T, 0374T
CMS-BEHAVIOR-CHANGE	99406, 99407, G0376, G0436, G0437
CMS-BIOFEEDBACK	90901, 90902
CMS-CARDIO	93750, 93797, 93798
CMS-COGNITIVE	99483
CMS-CRITICAL-CARE	99291, 99292, 99293, 99294, 99295, 99296, 99297, 99299, 99300, 99468, 99469, 99471, 99472, 99475, 99476, 99477, 99478, 99479, 99480
CMS-CUSTODIAL-CARE	99323, 99324, 99325, 99326, 99327, 99328, 99333, 99334, 99335, 99336, 99337
CMS-DIABETES-MGMT	G0108, G0109
CMS-EDUCATION-SVCS	G0420, G0421
CMSCMS-EMERGENCY-DEPT	99281, 99282, 99283, 99284, 99285
CMS-ESRD-CARE-MGMT	90951, 90952, 90953, 90954, 90955, 90956, 90957, 90958, 90959, 90960, 90961, 90962, 90963, 90964, 90965, 90966, 90967, 90968, 90969, 90970, 90995
CMS-HOME	99341, 99342, 99343, 99344, 99345, 99347, 99348, 99349, 99350, 99351, 99353
CMS-HOSPITAL-OBS-AND-IP	99217, 99218, 99219, 99220, 99221, 99222, 99223, 99224, 99225, 99226, 99231, 99232, 99233, 99234, 99235, 99236, 99238, 99239, 99262, 99263
CMS-MISC-MGMT	G0296, G0442, G0443, G0444, G0445, G0446, G0447, G0506
CMS-MONITORING	99473
CMS-NERVOUS-SYSTEM	90830, 95881, 96100, 96101, 96102, 96105, 96110, 96111, 96112, 96113, 96115, 96116, 96118, 96119, 96121, 96125, 96127, 96130, 96131, 96132, 96133, 96136, 96137, 96138, 96139
CMS-NEUROSTIMULATORS	63690, 95970, 95971, 95972, 95978, 95979, 95983, 95984
CMS-NURSING-FACILITY	99303, 99304, 99305, 99306, 99307, 99308, 99309, 99310, 99312, 99315, 99316, G9685
CMS-NUTRITION-THERAPY	97802, 97803, 97804, G0270
CMS-OFFICE-AND-OP	21800, 99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, 99215
CMS-OPHTHAMOLOGY	92002, 92004, 92012, 92014, 92330
CMS-OTORHINO	92506, 92507, 92508, 92521, 92522, 92523, 92524, 92525, 92526, 92601, 92602, 92603, 92604, 92607, 92608, 92609, 92610, 92625, 92626, 92627, G0200
CMS-PROLONGED	99354, 99355, 99356, 99357, G0513, G0514, G2211, G2212
CMS-PSYCH	90785, 90791, 90792, 90801, 90804, 90805, 90806, 90807, 90808, 90813, 90817, 90827, 90832, 90833, 90834, 90836, 90837, 90838, 90839, 90840, 90843, 90844, 90845, 90846, 90847, 90853, 90857, 90875, G0072, G0410
CMS-PULMONARY	94002, 94003, 94004, 94005, 94625, 94626, 94664
CMS-RADIATION-MGMT	77427
CMS-REHAB	95831, 95832, 95833, 95834, 97001, 97002, 97003, 97004, 97100, 97110, 97112, 97114, 97116, 97127, 97129, 97130, 97145, 97150, 97151, 97152, 97153, 97154, 97155, 97156, 97157, 97158, 97161, 97162, 97163, 97164, 97165, 97166, 97167, 97168, 97530, 97532, 97535, 97537, 97542, 97750, 97755, 97760, 97761, 97762, 97763, 0359T, 0360T, 0361T, 0364T, 0365T, 0366T, 0367T, 0368T, 0369T, 0370T, 0371T, 0372T, G0422, G0423, S9152
CMS-SELF-CARE-MGMT	98960, 98961, 98962
CMS-SUBSTANCE-ABUSE	G0396, G0397, G2086, G2087, G2088
CMSCMS-TELEHEALTH	G0459
CMSCMS-TELEHEALTH-CONSULT	G0406, G0407, G0408, G0425, G0426, G0427, G0508, G0509
CMS-TRANSITIONAL-CARE	99495, 99496
CMS-VIRTUAL	99372, 99373, 99441, 99442, 99443
CMS-WELLNESS	G0438, G0439

Appendix 9: Predictive Models

Data scientists have used Long short-term memory (LSTM) networks to predict the number of confirmed COVID-19 cases in different countries, considering factors such as population density, health care infrastructure and government response. Gated recurrent unit (GRU) networks have been used for similar tasks, such as predicting the number of COVID-19 deaths in different regions. Bidirection LSTM (BiLSTM) networks, which combine the capabilities of both LSTM and regular recurrent neural networks (RNNs), have been used to analyze text data such as news articles and social media posts to track the spread of misinformation related to COVID-19. Because of those, we selected RNN models to forecast telehealth utilization.

RNNs are deep learning models that are typically used to solve time series problems. They can learn from events that happened in recent previous iterations of their training stage. They have the property that one observation helps to train the next observation; therefore, RNNs are useful in solving time series.

RNNs have a "memory" that enables them to maintain an internal state across multiple time steps, which enables them to learn and make decisions based on information from earlier time steps.

LSTM networks are a specific type of RNN that are designed to handle the problem of vanishing gradients, which can make it difficult for standard RNNs to learn long-term dependencies in sequential data. LSTM networks use a special memory cell and a set of gates (input, output and forget) that control how information flows into and out of the cell, allowing the network to selectively retain or discard information over time.

GRU is another type of RNN, where it has two gates rather than three gates in LSTM. The two gates are update gate and reset gate. It can also handle long-term dependencies in sequential data.

BiLSTM is an extension of the LSTM model, where the hidden state of the LSTM is fed in both forward and backward direction, giving the model access to both past and future context.

Finally, a standard RNN is the most basic type of RNN. It processes one element in the sequence at a time and maintains a hidden state that is passed from one time step to the next.

METHODOLOGY

In all the populations we analyzed, there was a significant increase in telehealth utilization — which we will call "shock" — associated directly with COVID-19. The observed data does not take into consideration some externalities that will be present in the forecast period and that may directly affect telehealth utilization. To mitigate the impact of the shock in those time series, we adjusted 2019 telehealth utilization. We made the adjustment based on the assumption that there is a part of the population that given the opportunity, which now is more available, will select to have a telehealth appointment.

The levels of utilization of 2019 were adjusted by multiplying the monthly total utilization in 2019 by the average proportion of telehealth utilization to the total utilization observed in a period where the impact of the larger shock seemed to have passed.

We used data from January 2019 to May 2022 to compare the different versions of RNN analyzed.

For each population we analyzed, we selected the model to use by first comparing the models with mean squared error and root mean squared error and default hyperparameters. In the second iteration, we analyzed the two best models by doing a random search and Bayesian hyperparameter tuning. The parameters to optimize were the units and the learning rate of the RNNs. We then trained the best model on all the observed data and tuned with the method that gave the best performance in the prior step.

Model specifics for each of the population studied include:

MODEL SPECIFICS FOR COMMERCIAL MHSA

First Iteration		Second Iteration	
RNN		**BILSTM With Random Search**	
Mean Absolute Error	0.0857	Mean Absolute Error	0.2754
Root Mean Square Error	0.0916	Root Mean Square Error	0.3849
LSTM		**BILST With Bayesian Optimization**	
Mean Absolute Error	0.0524	Mean Absolute Error	0.3047
Root Mean Square Error	0.0782	Root Mean Square Error	0.4180
GRU		**GRU With Random Search**	
Mean Absolute Error	0.0402	Mean Absolute Error	0.2732
Root Mean Square Error	0.0612	Root Mean Square Error	0.3689
BILSTM		**GRU With Bayesian Optimization**	
Mean Absolute Error	0.0346	Mean Absolute Error	0.3135
Root Mean Square Error	0.0523	Root Mean Square Error	0.4298

MODEL SPECIFICS FOR COMMERCIAL E&M

First Iteration		Second Iteration	
RNN		**BILSTM With Random Search**	
Mean Absolute Error	0.4843	Mean Absolute Error	0.1100
Root Mean Square Error	0.5260	Root Mean Square Error	0.1474
LSTM		**BILST With Bayesian Optimization**	
Mean Absolute Error	1.0175	Mean Absolute Error	0.1129
Root Mean Square Error	1.0845	Root Mean Square Error	0.1514
GRU		**GRU With Random Search**	
Mean Absolute Error	0.1176	Mean Absolute Error	0.1167
Root Mean Square Error	0.1307	Root Mean Square Error	0.1567
BILSTM		**GRU With Bayesian Optimization**	
Mean Absolute Error	0.1521	Mean Absolute Error	0.1245
Root Mean Square Error	0.1701	Root Mean Square Error	0.1499

MODEL SPECIFICS FOR MEDICARE MHSA

First Iteration		Second Iteration	
RNN		**BILSTM With Random Search**	
Mean Absolute Error	0.4097	Mean Absolute Error	0.2273
Root Mean Square Error	0.7395	Root Mean Square Error	0.3170
LSTM		**BILST With Bayesian Optimization**	
Mean Absolute Error	1.3666	Mean Absolute Error	0.2188
Root Mean Square Error	1.5826	Root Mean Square Error	0.3109
GRU		**GRU With Random Search**	
Mean Absolute Error	1.1587	Mean Absolute Error	0.2284
Root Mean Square Error	1.3279	Root Mean Square Error	0.3182
BILSTM			
Mean Absolute Error	1.1429		
Root Mean Square Error	1.2896		

MODEL SPECIFICS FOR MEDICARE E&M

First Iteration		Second Iteration	
RNN		**BILSTM With Random Search**	
Mean Absolute Error	3.3923	Mean Absolute Error	0.0571
Root Mean Square Error	3.5961	Root Mean Square Error	0.0774
LSTM		**BILST With Bayesian Optimization**	
Mean Absolute Error	3.1311	Mean Absolute Error	0.0579
Root Mean Square Error	3.4709	Root Mean Square Error	0.0749
GRU		**GRU With Random Search**	
Mean Absolute Error	0.6500	Mean Absolute Error	0.0562
Root Mean Square Error	0.8745	Root Mean Square Error	0.0766
BILSTM		**GRU With Bayesian Optimization**	
Mean Absolute Error	2.2940	Mean Absolute Error	0.0737
Root Mean Square Error	2.3273	Root Mean Square Error	0.0861

Appendix 10: Rural-Urban Commuting Area Codes

Rural-Urban Commuting Area (RUCA) codes are mapped to U.S. ZIP codes using population density commuting flows. The definitions for RUCA codes are:

RUCA	Definition
1	Metropolitan area core: primary flow within an urbanized area (UA)
2	Metropolitan area high commuting: primary flow 30% or more to a UA
3	Metropolitan area low commuting: primary flow 10% to 30% to a UA
4	Micropolitan area core: primary flow within an urban cluster (UC) of 10,000 to 49,999 (large UC)
5	Micropolitan high commuting: primary flow 30% or more to a large UC
6	Micropolitan low commuting: primary flow 10% to 30% to a large UC
7	Small-town core: primary flow within a UC of 2,500 to 9,999 (small UC)
8	Small-town high commuting: primary flow 30% or more to a small UC
9	Small-town low commuting: primary flow 10% to 30% to a small UC
10	Rural areas: primary flow to a tract outside a UA or UC

References

Abbasi, J. 2022. “Pushed to Their Limits, 1 in 5 Physicians Intends to Leave Practice.” *JAMA* 327, no. 15:1435-1437. https://doi:10.1001/jama.2022.5074.

Adepojua, O.E., M. Chaeb, W. Liawa, T. Angeloccic, P. Millard, and O. Matuk-Villazon. 2022. “Transition to Telemedicine and Its Impact on Missed Appointments in Community-based Clinics.” *Annals of Medicine* 54, no. 1:98–107. https://doi: 10.1080/07853890.2021.2019826.

Ahmad, F., R.W. Wysocki, J.J. Fernandez, M.S. Cohen, and X.C. Simcock. 2021. “Patient Perspectives on Telemedicine During the COVID-19 Pandemic.” *Hand* 18, no. 3. https://doi.org/10.1177/15589447211030692.

Alexander, C, M. Tajanlangit, J. Heyward, O. Mansour, D.M. Qato, and R.S. Stafford. 2020. “Use and Content of Primary Care Office-Based vs Telemedicine Care Visits During the COVID-19 Pandemic in the US.” *JAMA Network Open* 3, no. 10:e2021476. https://doi:10.1001/jamanetworkopen.2020.21476.

Alkilany, R., Y. Tarabichi, and R. Hong. 2021. “Telemedicine Visits During COVID-19 Improved Clinic Show Rates.” *ACR Open Rheumatology*; epub. https://doi 10.1002/acr2.11372.

Alkureishi, M.A., G. Lenti, Z. Choo, J. Castaneda, G. Weyer, J. Oyler, and W.W. Lee. 2021. “Teaching Telemedicine: The Next Frontier for Medical Educators.” *JMIR. Med Educ.* 7, no. 2:e29099. https://doi:10.2196/29099.

Arnetz, B.B., C.M. Goetz, J.E. Arnetz, S. Sudan, J. vanSchagen, K. Piersma, F. Reyelts. 2020. “Enhancing Healthcare Efficiency to Achieve the Quadruple Aim: An Exploratory Study.” *BMC Res Notes* 13, no. 1:362. https://doi:10.1186/s13104-020-05199-8.

Archambault, J., and V. Nastasi. 2022. “Rating the States on Telehealth Best Practices. A Toolkit for a Pro-Patient and Provider Landscape.” Cicero Institute, January 5, 2022. https://ciceroinstitute.org/research/rating-the-states-on-telehealth-best-practices.

Aubert, C.E., J.B. Henderson, E.A. Kerr, R. Holleman, M.L. Klamerus, and T.P. Hofer. 2022. “Type 2 Diabetes Management, Control and Outcomes During the COVID-19 Pandemic in Older US Veterans: an Observational Study.” *J Gen Intern Med.* 37, no. 4:870-877. https://doi:10.1007/s11606-021-07301-7.

Bailey, V. 2021a. “US Reps Introduce Bill to Ensure Permanent Access to Telehealth.” mHealthIntelligence, December 10, 2021. https://mhealthintelligence.com/news/us-reps-introduce-bill-to-ensure-permanent-access-to-telehealth.

———. 2021b. “Senate Bill Aims to Solidify Medicare Coverage for Telehealth.” mHealthIntelligence, November 8, 2021. https://mhealthintelligence.com/news/senate-bill-aims-to-solidify-medicare-coverage-for-telehealth.

Balut, M.D., T. Wyte-Lake, W.N. Steers, K. Chu, A. Dobalian, B. Ziaeian, L. Heyworth, and C. Der-Martirosian. 2022. “Expansion of Telemedicine During COVID-19 at a VA Specialty Clinic.” *Healthc (Amst)* 10, no. 1:100599. https://doi:10.1016/j.hjdsi.2021.100599.

Barber, C.E.H., D.M. Levy, V. Ahluwalia, A. Mendel, R. Taylor-Gjevre, T. Gerschman, S. Koppikar, et al. 2022. “Best Practices for Virtual Care: A Consensus Statement From the Canadian Rheumatology Association.” *J Rheumatol.* 50, no. 5. https://doi.org/10.3899/jrheum.211017.

Barnett, M.L., H.A. Huskamp, A.B. Busch, L. Uscher-Pines, K.H. Chaiyachati, and A. Mehrotra. 2021. “Trends in Outpatient Telemedicine Utilization Among Rural Medicare Beneficiaries, 2010 to 2019.” *JAMA Health Forum* 2, no. 10:e213282. https://doi:10.1001/jamahealthforum.2021.3282.

Bashshur, R.L., C.R. Doarn, J.M. Frenk, J.C. Kvedar, G.W. Shannon, and L.O. Woolliscroft. 2020. “Beyond the COVID Pandemic, Telemedicine, and Health Care.” *Telemedicine and e-Health* 26, 11: 1310-1313. https://doi.org/10.1089/tmj.2020.0328.

Bashshur, R.L., G.W. Shannon, N. Bashshur, and P.M. Yellowlees. 2016. “The Empirical Evidence for Telemedicine Interventions in Mental Disorders.” *Telemed J E Health* 22:87-113.

Bearnes, R.D., B. Feenstra, J. Malcolm, S. Nelson, A. Garon-Mailer, A. Forster, and H. Clark. 2021. “Virtual Care and the Pursuit of the Quadruple Aim: A Case Example.” *Healthcare Management Forum* 34, no. 1:9-14. https://doi.org/10.1177/0840470420952468.

Beneteau, E., A. Paradiso, and W. Pratt. 2022. “Telehealth Experiences of Providers and Patients Who Use Augmentative and Alternative Communication.” *Journal of the American Medical Informatics Association* 29, no. 3:481-488. https://doi.org/10.1093/jamia/ocab273.

Bernstein, C. n.d. “Digital Health (Digital Healthcare).” *TechTarget.* Accessed May, 23, 2023. https://www.techtarget.com/searchhealthit/definition/digital-health-digital-healthcare.

Bertrand, S.E., M.A. Weinstock, and S.M. Landow. 2019. “Teledermatology Outcomes in the Providence Veterans Health Administration.” *Telemedicine and eHealth* 25, no. 12:1183-1188. https://doi.org/10.1089/tmj.2018.0242.

Berwick, D.M., T.W. Nolan, and J. Whittington. 2008. "The Triple Aim: Care, Health, and Cost." *Health Aff (Millwood)* 27, no. 3:759-69.

Bestsennyy, O., G. Gilbert, A. Harris, and J. Rost. 2021. "Telehealth: A Quarter-Trillion Dollar Post-COVID Reality?" *McKinsey & Company,* July 9, 2021. https://www.mckinsey.com/industries/healthcare/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality.

Bhargava, R., G. Gayre, J. Huang, E. Sievers, and M. Reed. 2021. "Patient e-Visit Use and Outcomes for Common Symptoms in an Integrated Health Care Delivery System." *JAMA Network Open* 4, no. 3:e212174. https://doi:10.1001/jamanetworkopen.2021.2174.

Blue Cross and Blue Shield of North Carolina. 2015. "The Non-Emergency Emergency: Reducing Avoidable ER Visits." August 28, 2015. https://www.bluecrossnc.com/provider-news/non-emergency-emergency-reducing-avoidable-er-visits.

Bowman, C.A., M. Nuh, and A. Rahim. 2021. "COVID-19 Telehealth Expansion Can Help Solve the Health Care Underutilization Challenge." *Am J Manag Care* 27:9-11. https://doi.org/10.37765/ajmc.2021.88571.

Bramati, P.S., J.S. Amaram-Davila, A.S. Reddy, and E. Bruera. 2022. "Reduction of Missed Palliative Care Appointments After the Implementation of Telemedicine." *Journal of Pain and Symptom Management*; epub. https://doi.org/10.1016/j.jpainsymman.2022.02.001.

Brotman, J.J., and R.M. Kotloff. 2021. "Providing Outpatient Telehealth Services in the United States Before and During Coronavirus Disease 2019." *Chest.* 159, 4:1548-1558. https://doi.org/10.1016/j.chest.2020.11.020.

Brunton, C., M.B. Arensberg, S. Drawert, C. Badaracco, W. Everett, and S.M. McCauley. 2021. "Perspectives of Registered Dietitian Nutritionists on Adoption of Telehealth for Nutrition Care during the COVID-19 Pandemic." *Healthcare* 9:235. https://doi.org/10. 3390/healthcare9020235.

Budhwani, S., J. Fujioka, T. Thomas-Jacques, K. De Vera, P. Challa, R. De Silva, K. Fuller, et al. 2022. "Challenges and Strategies for Promoting Health Equity in Virtual Care: Findings and Policy Directions From a Scoping Review of Reviews." *J Am Med Inform Assoc.* 29, no. 5:990-999. https://doi/10.1093/jamia/ocac022.

Bunnell, B.E., J.F. Barrera, S.R. Paige, D. Turner, and B.M. Welch. 2020. "Acceptability of Telemedicine Features to Promote Its Uptake in Practice: A Survey of Community Telemental Health Providers." *Int. J. Environ. Res. Public Health* 17:8525. https://doi.org/10.3390/ijerph17228525.

Butzner, M, and Y. Cuffee. 2021. "Telehealth Interventions and Outcomes Across Rural Communities in the United States: Narrative Review." *J Med Internet Res.* 23, no. 8:e29575. https://doi: 10.2196/29575

Cao, Y.J., D. Chen, Y. Liu, and M. Smith. 2021. "Disparities in the Use of In-Person and Telehealth Primary Care Among High- and Low-Risk Medicare Beneficiaries During COVID-19." *J Patient Exp.* 8. https://doi.org/10.1177/23743735211065274.

Cantor, J.H., R.K. McBain, M.F. Pera, D.M. Bravata, and C.M. Whaley. 2021. "Who Is (and Is Not) Receiving Telemedicine Care During the COVID-19 Pandemic." *Am J Prev Med* 61, no. 3:434–438. https://doi.org/10.1016/j.amepre.2021.01.030.

Center for Connected Health Policy. 2023. “Welcome to the Policy Finder.” June 8, 2023. www.cchpca.org /all-telehealth-policies/

Choi, N.G., D.M. DiNitto, C.M. Marti, and B.Y. Choi. 2022. “Telehealth Use Among Older Adults During COVID-19: Associations With Sociodemographic and Health Characteristics, Technology Device Ownership, and Technology Learning.” *Journal of Applied Gerontology* 41, no. 3:600–609. https://doi:10.1177/0733464821 1047347.

Chua, I.S., V. Jackson, and M. Kamdar. 2020. “Webside Manner During the COVID-19 Pandemic: Maintaining Human Connection During Virtual Visits.” *Journal of Palliative Medicine* 23, 11:1507-1509. https://doi.org/10.1089/jpm.2020.0298.

Connor, J., Y. Zheng, K. Houle, and L. Cox. 2021. “Adopting Telehealth During The COVID-19 Era: The Urologist’s Perspective.” *Urology* 156:289-295. https://doi.org/10.1016/j.urology.2021.03.051.

Cordina, J., J. Fowkes, R. Malani, and L. Medford-Davis. 2022. “Patients Love Telehealth—Physicians Are Not So Sure.” *McKinsey & Company* February 22, 2022. https://www.mckinsey.com/industries/healthcare/our-insights/patients-love-telehealth-physicians-are-not-so-sure.

Cromartie. “Rural-urban Commuting Area Codes.” USDA Economic Research Service. March 22 2023. https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/

Curran, D.M., B.Y. Kim, N. Withers, D.S. Shepard, and C.J. Brady. 2022. “Telehealth Screening for Diabetic Retinopathy: Economic Modeling Reveals Cost Savings.” *Telemed J E Health* 28, no. 9:1300-1308. https://doi:10.1089/tmj.2021.0352.

Cutter, C., N.L. Berlin, and A.M. Fendrick. 2020. “Establishing a Value-Based ‘New Normal’ for Telehealth.” *Health Affairs,* October 8, 2020. https://www.healthaffairs.org/do/10.1377/hblog20201006.638022/full.

Davis, T.C., K.W. Hoover, S. Keller, and W.H. Replogle. 2020. “Mississippi Diabetes Telehealth Network: A Collaborative Approach to Chronic Care Management.” *Telemedicine and eHealth* 26, no. 2:184-189. https://doi:10.1089/tmj.2018.0334.

Day, S.C., G. Day, M. Keller, H. Touchett, A.B. Amspoker, L. Martin, and J.A. Lindsay. 2021. “Personalized Implementation of Video Telehealth for Rural Veterans (PIVOT-R).” *mHealth* 7:24. http://dx.doi.org/10.21037/mhealth.2020.03.02.

de Albornoz, S.C., K. Siaa, and A. Harris. 2022. “The Effectiveness of Teleconsultations in Primary Care: Systematic Review.” *Family Practice*. 39, no. 1:168-182. https://doi.org/10.1093/fampra/cmab077.

De Biase, G, W.D. Freeman, M. Bydon, N. Smith, D. Jerreld, J. Pascual, J. Casler, C. Hasse, A. Quiñones-Hinojosa, and K. Abode-Iyamah. 2020. “Telemedicine Utilization in Neurosurgery During the COVID-19 Pandemic: A Glimpse Into the Future?” *Mayo Clin Proc Inn Qual Out* 4, no. 6:736-744. https://doi.org/10.1016/j.mayocpiqo.2020.07.013

De Groot, J., D. Wu, D. Flynn, D. Robertson, G. Grant, and J. Sun. 2021. “Efficacy of Telemedicine on Glycaemic Control in Patients With Type 2 Diabetes: A Meta-analysis.” *World J Diabetes* 12, no. 2:170-197.

DeHart, D., L.B. King, A.L. Iachini, T. Browne, and M. Reitmeier. 2021. "Benefits and Challenges of Implementing Telehealth in Rural Settings: A Mixed-Methods Study of Behavioral Medicine Providers." *Health & Social Work* 47, no. 1:7-18. https://doi.org/10.1093/hsw/hlab036.

Donelan, K., E.A. Barreto, S. Sossong, C. Michael, J.J. Estrada, A.B. Cohen, J. Wozniak, and L.H. Schwamm. 2019. "Patient and Clinician Experiences With Telehealth for Patient Follow-up Care." *Am J Manag Care* 25, no. 1:40-44.

Doximity. "State of Telemedicine Report. Second Edition." Accessed May 23, 2023. https://c8y.doxcdn.com/image/upload/Press%20Blog/Research%20Reports/Doximity-Telemedicine-Report-2022.pdf.

Drake, C., T. Lian, B. Cameron, K. Medynskaya, H.B. Bosworth, and K. Shah. 2022. "Understanding Telemedicine's 'New Normal': Variations in Telemedicine Use by Specialty Line and Patient Demographics." *Telemedicine and eHealth* 28, no. 1:51-59. https://doi.org/10.1089/tmj.2021.0041.

Drerup, B., J. Espenschied, J. Wiedemer, and L. Hamilton. 2021. "Reduced No-Show Rates and Sustained Patient Satisfaction of Telehealth During the COVID-19 Pandemic." *Telemedicine and eHealth* 27, no. 12:1409-1415. https://doi: 10.1089/tmj.2021.0002.

Duryea, E.L., E.H. Adhikari, A. Ambia, C. Spong, D. McIntire, and D.B. Nelson. 2021. "Comparison Between In-Person and Audio-Only Virtual Prenatal Visits and Perinatal Outcomes." *JAMA Network Open* 4, no. 4:e215854. https://doi:10.1001/jamanetworkopen.2021.5854.

Ebbert, J.O., P. Ramar, S.M. Tulledge-Scheitel, J.W. Njeru, J.K. Rosedahl, D. Roellinger, and L.M. Philpot. 2021. "Patient Preferences for Telehealth Services in a Large Multispecialty Practice." *J Telemed Telecare*; epub. https://doi: 10.1177/1357633X20980302.

ECRI. n.d. "Top Ten Technology Hazards for 2022." Accessed May 23, 2023. http://www.ecri.org/2022hazards.

Elliott, T., I. Tong, A. Sheridan, and B.A. Lown. 2020. "Beyond Convenience: Patients' Perceptions of Physician Interactional Skills and Compassion via Telemedicine." *Mayo Clin Proc Inn Qual Out* 4, no. 3:305-314. https://doi.org/10.1016/j.mayocpiqo.2020.04.009

Franciosi, E.B., A.J. Tan, B. Kassamali, N. Leonard, G. Zhou, S. Krueger, M. Rashighi, and A. LaChance. 2021. "The Impact of Telehealth Implementation on Underserved Populations and No-Show Rates by Medical Specialty During the COVID-19 Pandemic." *Telemedicine and eHealth* 27, no. 8:874-880. https://doi: 10.1089/tmj.2020.0525.

Finn, M.T.M., H.R. Brown, E.R. Friedman, A.G. Kelly, and K. Hansen. 2021. "Preference for Telehealth Sustained Over Three Months at an Outpatient Center for Integrative Medicine." *Global Advances in Health and Medicine* 10:1-9. https://doi: 10.1177/2164956121997361.

FitzGerald, M., M.Z. Gunja, R. Tikkanen. 2022. "Primary Care in High-Income Countries: How the United States Compares." *The Commonwealth Fund*, March 15, 2022. https://www.commonwealthfund.org/publications/issue-briefs/2022/mar/primary-care-high-income-countries-how-united-states-compares.

Flodgren, G., A. Rachas, A.J. Farmer, M. Inzitari, S. Shepperd. 2015. "Interactive Telemedicine: Effects on Professional Practice and Health Care Outcomes." *Cochrane Database Syst Rev* 9:CD002098.

Friedman, A.B., S. Gervasi, H. Song, A.M. Bond, A.T. Chen, A. Bergman, G. David, J.M. Bailey, R. Brooks, and A. Smith-McLallen. 2022. "Telemedicine Catches On: Changes in the Utilization of Telemedicine Services During the COVID-19 Pandemic." *Am J Manag Care* 28, no. 1:e1-e6. https://doi:10.37765/ajmc.2022.88771.

Friedberg, M.W., P.G. Chen, K.R. Van Busum, F. Aunon, C. Pham, J.P. Caloyeras, S. Mattke, et al. 2014. "Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy." *RAND Health Quarterly* 3, no. 4:1.

Gentry, M.T., A.J. Puspitasari, A.J. McKean, M.D. Williams, S. Breitinger, J.R. Geske, M.M. Clark, K.M. Moore, M.A. Frye, and D.M. Hilty. 2021. "Clinician Satisfaction With Rapid Adoption and Implementation of Telehealth Services During the COVID-19 Pandemic." *Telemedicine and eHealth* 27, no. 12:1385-1392. https://doi.org/10.1089/tmj.2020.0575.

Ghaddar, S., K.P. Vatcheva, S.G. Alvarado, and L. Mykyta. 2020. "Understanding the Intention to Use Telehealth Services in Underserved Hispanic Border Communities: Cross-Sectional Study." *J Med Internet Res.* 22, no. 9:e21012. https://doi.org/10.2196/21012PMID: 32880579PMCID: 7499162.

Gilson, S.F., C.A. Umscheid, N. Laiteerapong, G. Ossey, K.J. Nunes, and S.D. Shah. 2020. "Growth of Ambulatory Virtual Visits and Differential Use by Patient Sociodemographics at One Urban Academic Medical Center During the COVID-19 Pandemic: Retrospective Analysis." *JMIR Med Inform* 8, no. 12:e24544. https://doi:10.2196/24544.

Glennie, J.L., L. Berard, and F. Levrat-Guillen. 2022. "Sensor-Based Technology: Bringing Value to People with Diabetes and the Healthcare System in an Evolving World." *Clinicoecon Outcomes Res.* 10, no. 14:75-90. https://doi:10.2147/CEOR.S346736.

Goldberg, E.M., M.P. Lin, L.G. Burke, F.N. Jiménez, N.M. Davoodi, and R.C. Merchant. 2022. "Perspectives on Telehealth for Older Adults During the COVID-19 Pandemic Using the Quadruple Aim: Interviews With 48 Physicians." *BMC Geriatr* 22, no. 1:188. https://doi:10.1186/s12877-022-02860-8.

Graetz, I, J. Huang, E. Muelly, A. Gopalan, and M.E. Reed. 2022. "Primary Care Visits Are Timelier When Patients Choose Telemedicine: A Cross-Sectional Observational Study." *Telemed J E Health*; epub. https://doi:10.1089/tmj.2021.0528.

Greiwe, J. 2022. "Telemedicine Lessons Learned During the COVID-19 Pandemic." *Current Allergy and Asthma Reports* 22:1-5. https://doi.org/10.1007/s11882-022-01026-1.

Gujral, K., J.Y. Scott, L. Ambady, C.E. Dismuke-Greer, J. Jacobs, A. Chow, A. Oh, and J. Yoon. 2022. "A Primary Care Telehealth Pilot Program to Improve Access: Associations with Patients' Health Care Utilization and Costs." *Telemedicine and eHealth* 28, no. 5. http://doi.org/10.1089/tmj.2021.0284.

Hakkennes, S., and P. Singh. 2020. "Market Guide for Virtual Care Solutions." Gartner, October 26, 2020. https://www.gartner.com/en/documents/3992183.

Hamadi, H., M. Zhao, D.R. Haley, A. Dunn, S. Paryani, and A. Spaulding. 2021. "Medicare and Telehealth: The Impact of COVID-19 Pandemic." *J Eval Clin Pract* 28, no. 1:43-48. https://doi: 10.1111/jep.13634.

Harerimana, B., C. Forchuk, and T. O'Regan. 2019. "The Use of Technology for Mental Healthcare Delivery Among Older Adults With Depressive Symptoms: A Systematic Literature Review." *International Journal of Mental Health Nursing* 28:657–670. https://doi: 10.1111/inm.12571.

HealthStream. 2021. "What is the Quadruple Aim – Four Strategies for Improving Healthcare." August 6, 2021. https://www.healthstream.com/resource/blog/what-is-the-quadruple-aim-four-strategies-for-improving-healthcare.

Herzer, K.R., and P.J. Pronovost. 2021. "Ensuring Quality in the Era of Virtual Care." *JAMA* 325, no. 5:429-430. https://doi: 10.1001/jama.2020.24955

Hsueh, L., J. Huang, A.K. Millman, A. Gopalan, R.K. Parikh, S. Teran, and M.E. Reed. 2021. "Disparities in Use of Video Telemedicine Among Patients With Limited English Proficiency During the COVID-19 Pandemic." *JAMA Netw Open* 4, no. 11:e2133129. https://doi.org/10.1001/jamanetworkopen.2021.33129.

Hunsinger, N., R. Hammarlund, and K. Crapanzano. 2021. "Mental Health Appointments in the Era of COVID-19: Experiences of Patients and Providers." *Ochsner Journal* 21:335–340. https://doi: 10.31486/toj.21.0039.

Jacobs, J., J.M. Ferguson, J. Van Campen, M. Yefimova, L. Greene, L. Heyworth, and D.M. Zulman. 2022. "Organizational and External Factors Associated With Video Telehealth Use in the Veterans Health Administration Before and During the COVID-19 Pandemic." *Telemedicine and eHealth* 28, no. 2:199-211. https://doi:10.1089/tmj.2020.0530.

Jetty, A., Y. Jabbarpour, M. Westfall, D.B. Kamerow, S. Petterson, and J.M. Westfall. 2021. "Capacity of Primary Care to Deliver Telehealth in the United States." *J Am Board Fam Med.* 34:S48-S54. https://doi.org/10.3122/jabfm.2021.S1.200202.

Jewett, P.I., R.I. Vogel, R. Ghebre, J.Y.C. Hui, H.M. Parsons, A. Rao, S. Sagaram, and A.H. Blaes. 2022. "Telehealth in Cancer Care During COVID-19: Disparities by Age, Race/Ethnicity, and Residential Status." *J Cancer Surviv.* 16, no. 1:44-51. https://doi.org/10.1007/s11764-021-01133-4.

Johnson, B.A., B.R. Lindgren, A.H. Blaes, H.M. Parsons, C.J. LaRocca, R. Farah, and J.Y.C. Hui. 2021. "The New Normal? Patient Satisfaction and Usability of Telemedicine in Breast Cancer Care." *Ann Surg Oncol.* 28:5668-5676. https://doi.org/10.1245/s10434-021-10448-6.

Kalwani, N.M., E. Osmanlliu, V. Parameswaran, L. Qureshi, R. Dash, P.A. Heidenreich, D. Scheinker, and F. Rodriguez. 2022. "Changes in Telemedicine Use and Ambulatory Visit Volumes at a Multispecialty Cardiovascular Center During the COVID-19 Pandemic." *Journal of Telemedicine and Telecare*; epub. https://doi: 10.1177/1357633X211073428.

Karimi, M., E.C. Lee, S.J. Couture, A.B. Gonzales, V. Grigorescu, S.R. Smith, N. De Lew, and B.D. Sommers. 2022. "National Trends in Telehealth Use in 2021: Disparities in Utilization and Audio vs. Video Services." Office of the Assistant Secretary for Planning and Evaluation, U. S. Department of Health and Human Services, February 2022. https://aspe.hhs.gov/reports/hps-analysis-telehealth-use-2021.

Katz, A.J., K. Haynes, S. Du, J. Barron, R. Kubik, and R.C. Chen. 2022. "Evaluation of Telemedicine Use Among US Patients With Newly Diagnosed Cancer by Socioeconomic Status." *JAMA Oncology* 8, no. 1:161-163. https://doi:10.1001/jamaoncol.2021.5784.

Kichloo, A., M. Albosta, K. Dettloff, F. Wani, Z. El-Amir, J. Singh, M. Aljadah, et al. 2020. "Telemedicine, the Current COVID-19 Pandemic and the Future: a Narrative Review and Perspectives Moving Forward in the USA." *Fam Med Com Health* 8:e000530. https://doi:10.1136/fmch-2020-000530.

Kimball, A.B. 2022. "How Should Telehealth Be Reimbursed?" *Becker's Hospital Review,* March 29, 2022. https://www.beckershospitalreview.com/telehealth/how-should-telehealth-be-reimbursed.html.

Kintzle, S., W.A. Rivas, C.A. Castro, and S. Dworak-Peck. Forthcoming. "Satisfaction of the Use of Telehealth and Access to Care for Veterans During the COVID-19 Pandemic." *Telemedicine and eHealth*. http://doi.org/10.1089/tmj.2021.0262.

Knierim, K., C. Palmer, E.S. Kramer, R.S. Rodriguez, J. VanWyk, A. Shmerling, P. Smith, et al. 2021. "Lessons Learned During COVID-19 That Can Move Telehealth in Primary Care Forward." *J Am Board Fam Med* 34:S196-S202. https://doi: 10.3122/jabfm.2021.S1.200419.

Kolmar, C. 2023. "25+ Incredible US Smartphone Industry Statistics [2023]: How Many Americans Have Smartphones." *Zippia*. https://www.zippia.com/advice/us-smartphone-industry-statistics/.

Koonin, L.M., B. Hoots, C.A. Tsang, Z. Leroy, K. Farris, B. Jolly, P. Antall, et al. 2020. "Trends in the Use of Telehealth During the Emergence of the COVID-19 Pandemic — United States, January–March 2020." *MMWR* 69, no. 43:1595-1599.

Kruse, C.S., M. Soma, D. Pulluri, N.T. Nemali, and M. Brooks. 2017. "The Effectiveness of Telemedicine in the Management of Chronic Heart Disease – a Systematic Review." *Journal of the Royal Society of Medicine Open* 8, no. 3:1-7. https://doi:10.1177/2054270416681747.

Kruse, C.S., N. Krowski, B. Rodriguez, L. Tran, J. Vela, M. Brooks. 2017. "Telehealth and Patient Satisfaction: a Systematic Review and Narrative Analysis." *BMJ Open* 7:e016242. https://doi:10.1136/bmjopen-2017-016242.

Krzyzaniak, N., H. Greenwood, A.M. Scott, R. Peiris, M. Cardona, J. Clark, P. Glasziou. 2021. "The Effectiveness of Telehealth Versus Face-to-Face Interventions for Anxiety Disorders: A Systematic Review and Meta-Analysis." *Journal of Telemedicine and Telecare*. https://doi:10.1177/1357633X211053738.

Kubes, J.N., I. Graetz, Z. Wiley, N. Franks, and A. Kulshreshtha. 2021. "Associations of Telemedicine vs. In-person Ambulatory Visits and Cancellation Rates and 30-Day Follow-up Hospitalizations and Emergency Department Visits." *Preventive Medicine Reports* 24:101629. https://doi.org/10.1016/j.pmedr.2021.101629.

Langabeer, J.R., T. Champagne-Langabeer, D. Alqusairi, J. Kim, A. Jackson, D. Persse, and M. Gonzalez. 2017. "Cost–Benefit Analysis of Telehealth in Pre-hospital Care." *Journal of Telemedicine and Telecare* 23, no. 8:747-751. https://doi:10.1177/1357633X16680541.

Leader, J.K., C.M. Hakim, M.A. Ganott, D.M. Chough, L.P. Wallace, R.J. Clearfield, R.L. Perrin, et al. 2006. "A Multisite Telemammography System for Remote Management of Screening Mammography: An Assessment of Technical, Operational, and Clinical Issues." *Journal of Digital Imaging* 19, no. 3:216-225. https://doi:10.1007/s10278-006-0585-9.

Lee, J., and Hughes T. 2017. "Telemedicine: What Actuaries Should Look for." *Health Watch* 83:38-40.

Lee, M., P. Luna, S. Lynch, S. Nagpal, Y. Castro-Dominguez, Z. Ahmed, A. Brice, A. Arham, K.G. Smolderen, and C. Mena-Hurtado. “Telehealth User Experiences During COVID-19: A Case Study of Outpatient Cardiovascular Clinics Affiliated With a Large Academic Practice.” *The American Journal of Accountable Care* 9, no. 4.

Li, K.Y., Z. Zhu, S. Ng, and C. Ellimoottil. 2021. “Direct-to-Consumer Telemedicine Visits for Acute Respiratory Infections Linked to More Downstream Visits.” *Health Affairs* 40, no. 4:596-602. https://doi:10.1377/hlthaff.2020.01741.

Li, K.Y., S. Ng, Z. Zhu, J.S. McCullough, K.E. Kocher, and C. Ellimoottil. 2022. “Association Between Primary Care Practice Telehealth Use and Acute Care Visits for Ambulatory Care–Sensitive Conditions During COVID-19.” *JAMA Network Open* 5, no. 3:e225484. https://doi:10.1001/jamanetworkopen.2022.5484.

Lieu, T.A., M. Warton, C. Levan, K. San, L. Hsueh, S. Awsare, and M.E. Reed. 2022. “Association of Medical Assistant–Supported Virtual Rooming With Successful Video Visit Connections.” *JAMA Internal Medicine* 182, no. 6. https://doi.org/10.1001/jamainternmed.2022.1032.

Lin, J.C., D. Mclaughlin, D. Zurawski, N. Kennedy, and L. Kabbani. 2020. “Comparison of Virtual Visit Versus Traditional Clinic for Management of Varicose Veins.” *Journal of Telemedicine and Telecare* 26, no. 1-2:100-104. https://doi:10.1177/1357633X18797181.

Liu, X., S. Goldenthal, M. Li, S. Nassiri, E. Steppe, and C. Ellimoottil. 2021. “Original Research Comparison of Telemedicine Versus In-Person Visits on Impact of Downstream Utilization of Care.” *Telemedicine and eHealth* 27, no. 10:1099-1104. https://doi:10.1089/tmj.2020.0286.

Lo, J., M. Rae, K. Amin, and C. Cox. 2022. “Outpatient Telehealth Use Soared Early in the COVID-19 Pandemic but Has Since Receded.” Kaiser Family Foundation, Feb. 10, 2022. https://www.kff.org/coronavirus-covid-19/issue-brief/outpatient-telehealth-use-soared-early-in-the-covid-19-pandemic-but-has-since-receded.

Lo, J., M. Rae, K. Amin, C. Cox, N. Panchal, and B.F. Miller. 2022. “Telehealth Has Played an Outsized Role Meeting Mental Health Needs During the COVID-19 Pandemic.” Kaiser Family Foundation, March 15, 2022. https://www.kff.org/coronavirus-covid-19/issue-brief/telehealth-has-played-an-outsized-role-meeting-mental-health-needs-during-the-covid-19-pandemic.

Lundström, L., O. Flygare, E. Andersson, J. Enander, M. Bottai, V.Z. Ivanov, J. Boberg, D. Pascal, D. Mataix-Cols, C. Ruck. 2022. “Effect of Internet-Based vs Face-to-Face Cognitive Behavioral Therapy for Adults With Obsessive-Compulsive Disorder A Randomized Clinical Trial.” *JAMA Network Open* 5, no. 3:e221967. https://doi:10.1001/jamanetworkopen.2022.1967.

Mahtta, D., M. Daher, M.T. Lee, S. Sayani, M. Shishehbor, and S.S. Virani. 2021. “Promise and Perils of Telehealth in the Current Era.” *Current Cardiology Reports* 23:115. https://doi.org/10.1007/s11886-021-01544-w.

Malouff, T.D., S.P. TerKonda, D. Knight, A.M.A. Dabrh, A.I. Perlman, B. Munipalli, D.V. Dudenkov, et al. 2021. “Physician Satisfaction With Telemedicine During the COVID-19 Pandemic: The Mayo Clinic Florida Experience.” *Mayo Clin Proc Inn Qual Out.* 5, no. 4:771-782. https://doi.org/10.1016/j.mayocpiqo.2021.06.006.

Mann, D.M., J. Chen, R. Chunara, P.A. Testa, and O. Nov. 2020. “COVID-19 Transforms Health Care Through Telemedicine: Evidence From the Field.” *Journal of the American Medical Informatics Association* 27, no. 7:1132–1135. https://doi: 10.1093/jamia/ocaa072.

Markert, C., F. Sasangohar, B.J. Mortazavi, and S. Fields. 2021. “The Use of Telehealth Technology to Support Health Coaching for Older Adults: Literature Review.” *JMIR Hum Factors* 8, no. 1:e23796. https://doi:10.2196/23796.

McConnochie, K.M. 2019. “Webside Manner: A Key to High-Quality Primary Care Telemedicine for All.” *Telemedicine and eHealth* 25, no. 11:1033-1039. https://doi.org/10.1089/tmj.2018.0274.

McLendon, S.F. 2017. “Interactive Video Telehealth Models to Improve Access to Diabetes Specialty Care and Education in the Rural Setting: A Systematic Review.” *Diabetes Spectrum* 30, no. 2:124-136. https://doi.org/10.2337/ds16-0004.

Mehak, N., and R. Sharma. 2021. “A Review of Patient Satisfaction and Experience with Telemedicine: A Virtual Solution During and Beyond COVID-19 Pandemic.” *Telemedicine and eHealth* 27, no. 12:1325-1331. https://doi:10.1089/tmj.2020.0570.

Mehrotra, A., R.S. Bhatia, and C.L. Snoswell. 2021. “Paying for Telemedicine After the Pandemic.” *JAMA* 325, no. 5:431-432.

Melchionna, M. 2022. “Bipartisan Bill Aims to Increase Access to Virtual Mental Health Services.” mHealthIntelligence, April 12, 2022. https://mhealthintelligence.com/news/bipartisan-bill-aims-to-increase-access-to-virtual-mental-health-services.

Mileski, M., C.S. Kruse, J. Catalani, and T. Haderer. 2017. “Adopting Telemedicine for the Self-Management of Hypertension: Systematic Review.” *JIMR* 5, no. 4:e41, https://doi:10.2196/medinform.6603.

Mitchell, H. 2021. “43% of Americans Want to Use Telehealth After the Pandemic, Survey Finds.” *Becker’s Hospital Review*, June 4, 2021. https://www.beckershospitalreview.com/telehealth/43-of-americans-want-to-use-telehealth-after-the-pandemic-survey-finds.html.

Morgan, A., D. Goodman, J. Vinagolu-Baur, and I. Cass. 2022. “Prenatal Telemedicine During COVID-19: Patterns of Use and Barriers to Access.” *JAMIA Open.* 5, 1:1-6. https://doi.org/10.1093/jamiaopen/ooab116.

NBC News, “The surge in telemedicine fraud during the pandemic,” *NBC News* video, 3:29, April 1, 2022, https://www.nbcnews.com/nightly-news/video/the-surge-in-telemedicine-fraud-during-the-pandemic-136805445984.

Neeman, E., D. Kumar, L. Lyon, T. Kolevska, M. Reed, T. Sundaresan, A. Arora, et al. 2021. “Attitudes and Perceptions of Multidisciplinary Cancer Care Clinicians Toward Telehealth and Secure Messages.” *JAMA Network Open* 4, no. 11:e2133877. https://doi:10.1001/jamanetworkopen.2021.33877.

Nguyen, M.T., F. Garcia, J. Juarez, B. Zeng, E.C. Khoong, M.A. Nijagal, U. Sarkar, G. Su, C.R. Lyles . 2022. “Satisfaction Can Co-exist With Hesitation: Qualitative Analysis of Acceptability of Telemedicine Among Multi-lingual Patients in a Safety-net Healthcare System During the COVID-19 Pandemic.” *BMC Health Serv Res* 22:195. https://doi.org/10.1186/s12913-022-07547-9.

Nguyen, M., M. Waller, A. Pandya, and J. Portnoy. 2020. “A Review of Patient and Provider Satisfaction with Telemedicine.” *Current Allergy and Asthma Reports* 20:72. https://doi.org/10.1007/s11882-020-00969-7.

Nies, S., S. Patel, M. Shafer, L. Longman, I. Sharif, and P. Pina. 2021. “Understanding Physicians’ Preferences for Telemedicine During the COVID-19 Pandemic: Cross-sectional Study.” *JMIR Form Res.* 5, no. 8:e26565. https://doi.org/10.2196/26565.

Nord, G., K.L. Rising, R.A. Band, B.G. Carr, and J.E. Hollander. 2019. “On-demand Synchronous Audio Video Telemedicine Visits Are Cost Effective.” *Am J Emerg Med.* 37, no. 5:890-894. https://doi.org/10.1016/j.ajem.2018.08.017.

Nundy, S., L.A. Cooper, and K.S. Mate. 2022. “The Quintuple Aim for Health Care Improvement. A New Imperative to Advance Health Equity.” *JAMA* 327, no. 6:521-522.

Palmer, A., and B. Coombs. 2022. “Amazon Rolls Out Its Telehealth Service Nationwide.” *CNBC,* February 8, 2022. https://www.cnbc.com/2022/02/08/amazon-care-telehealth-service-launches-nationwide.html.

Park, S., B.A. Langellier, and D.J. Meyers. 2022. “Adoption of Telehealth Benefits by Medicare Advantage Plans in 2020 and 2021.” *J Gen Intern Med.* 37, 3:686-688. https://doi.org/10.1007/s11606-020-06535-1.

Parthasarathy, M, J. Khuntia, and R. Stacey. 2021. “Impact of Remote and Virtual Care Models on the Sustainability of Small Health Care Businesses: Perceptual Analysis of Small Clinics, Physician Offices, and Pharmacies in Colorado.” *J Med Internet Res.* 23, 2:e23658. https://doi.org/10.2196/23658.

Patel, S.Y., A. Mehrotra, H.A. Huskamp, L. Uscher-Pines, I. Ganguli, and M.L. Barnett. 2021. “Trends in Outpatient Care Delivery and Telemedicine During the COVID-19 Pandemic in the US.” *JAMA Internal Medicine* 181, no. 3:388-391. https://doi:10.1001/jamainternmed.2020.5928.

Payan, D.D., J.L. Frehn, L. Garcia, A.A. Tierney, and H.P. Rodriguez. 2022. “Telemedicine Implementation and Use in Community Health Centers During COVID-19: Clinic Personnel and Patient Perspectives.” *SSM – Qualitative Research in Health* 2.

Pekmezaris, R., C.N. Nouryan, R. Schwartz, S. Castillo, A.N. Makaryus, D. Ahern, M.B. Akerman. 2019. “A Randomized Controlled Trial Comparing Telehealth Self-Management to Standard Outpatient Management in Underserved Black and Hispanic Patients Living With Heart Failure.” *Telemedicine and eHealth* 25, no. 10:917-925. https://doi:10.1089/tmj.2018.0219.

Persaud, Y.K. 2022. “Using Telemedicine to Care for the Asthma Patient.” *Current Allergy and Asthma Reports* 22:43-52. https://doi.org/10.1007/s11882-022-01030-5.

Phenicie, R., R.A. Wright, and J. Holzberg. 2021. “Patient Satisfaction With Telehealth During COVID-19: Experience in a Rural County on the United States–Mexico Border.” *Telemedicine and eHealth* 27, no. 8:859-865. https://doi:10.1089/tmj.2021.0111.

Polonsky, W.H., J.E. Layne, C.G. Parkin, C.M. Kusiak, N.A. Barleen, D.P. Miller, H. Zisser, and R.F. Dixon. 2020. “Impact of Participation in a Virtual Diabetes Clinic on Diabetes-Related Distress in Individuals With Type 2 Diabetes.” *Clinical Diabetes* 38, no. 4:357-362. https://doi.org/10.2337/cd19-0105.

Qian, A.S., M.K. Schiaffino, V. Nalawade, L. Aziz, F.V. Pacheco, B. Nguyen, P. Vu, S.P. Patel, M.E. Martinez, and J.D. Murphy. 2022. “Disparities in Telemedicine During COVID-19.” *Cancer Med.* 11, no. 4:1192-1201. https://doi.org/10.1002/cam4.4518.

Quinton, J.K., M.K. Ong, C. Sarkisian, A. Casillas, S. Vangala, P. Kakani, and M. Han. 2022. “The Impact of Telemedicine on Quality of Care for Patients with Diabetes After March 2020.” *J Gen Intern Med.* 28:1-6; epub. https://doi:10.1007/s11606-021-07367-3.

Reed, M., J. Huang, I. Graetz, E. Muelly, A. Millman, and C. Lee. 2021. “Treatment and Follow-up Care Associated With Patient-Scheduled Primary Care Telemedicine and In-Person Visits in a Large Integrated Health System.” *JAMA Network Open* 4, no. 11:e2132793. https://doi:10.1001/jamanetworkopen.2021.32793.

Roland, J., D. Potter, and E. Caplan. 2023. “10 of the Best Telemedicine Companies.” https://www.healthline.com/health/best-telemedicine-companies#how-we-chose.

Sallam, A., M. Shang, I. Vallabhajosyula, M. Mori, R. Chinian, R. Assi, P. Bonde, A. Geirsson, and P. Vallabhajosyula. 2021. “Telemedicine in the Era of Coronavirus 19: Implications for Postoperative Care in Cardiac Surgery.” *J Card Surg.* 36:3731-3737. https://doi: 10.1111/jocs.15875.

Saloner, B., N. Krawczyk, K. Solomon, S.T. Allen, M. Morris, K. Haney, and S.G. Sherman. 2022. “Experiences With Substance Use Disorder Treatment During the COVID-19 Pandemic: Findings From a Multistate Survey.” *Int J Drug Policy* 101:103537. https://doi:10.1016/j.drugpo.2021.103537.

Samson, L.W., W. Tarazi, G. Turrini, and S. Sheingold. 2021. “Medicare Beneficiaries’ Use of Telehealth in 2020: Trends by Beneficiary Characteristics and Location.” Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services, Issue Brief No. HP-2021- 27, December. https://aspe.hhs.gov/reports/medicare-beneficiaries-use-telehealth-2020.

Saiyed, S., A. Nguyen, and R. Singh. 2021. “Physician Perspective and Key Satisfaction Indicators with Rapid Telehealth Adoption During the Coronavirus Disease 2019 Pandemic.” *Telemedicine and eHealth* 27, no. 11: 1225-1234. https://doi:10.1089/tmj.2020.0492.

Shigekawa, E., M. Fix, G. Corbett, D.H. Roby, and J. Coffman. 2018. “The Current State of Telehealth Evidence: A Rapid Review.” *Health Affairs* 37, no. 12:1975-1982. https://doi:10.1377/hlthaff.2018.05132.

Singh, J.A., J.S. Richards, E. Chang, A.M. Joseph, and B. Ng. 2022. “Telemedicine Use During the COVID-19 Pandemic by Resilient Rheumatology Providers: A National Veterans Affairs Follow-up Survey.” *The Journal of Rheumatology* 49, 4:424-431. https://doi.org/10.3899/jrheum.210967.

Spina, E., G. Tedeschi, A. Russo, F. Trojsi, R. Iodice, S. Tozza, A. Iovino, et al. 2022. “Telemedicine Application to Headache: a Critical Review.” *Neurological Sciences* 43:3795-3801. https://doi.org/10.1007/s10072-022-05910-6.

Star Tribune. 2021. “Keep moving forward on expanded telehealth in Minnesota.” *Star Tribune.* https://www.startribune.com/keep-moving-forward-on-expanded-telehealth-in-minnesota/600044837/

State of Rhode Island Department of Health. n.d. “Potentially Preventable Emergency Room Visits: Department of Health” Accessed May 23, 2023. https://health.ri.gov/data/potentiallypreventableemergencyroomvisits.

Stevens, J.P., O. Mechanic, L. Markson, A. O’Donoghue, and A.B. Kimball. 2021. “Telehealth Use by Age and Race at a Single Academic Medical Center During the COVID-19 Pandemic: Retrospective Cohort Study.” *J Med Internet Res.* 23, no. 5:e23905. https://doi.org/10.2196/23905.

Sugarman, D.E., L.E. Horvitz, S.F. Greenfield, and A.B. Busch. 2021. "Clinicians' Perceptions of Rapid Scale-up of Telehealth Services in Outpatient Mental Health Treatment." *Telemedicine and eHealth* 27, no. 12:1399-1408. https://doi.org/10.1089/tmj.2020.0481.

Sundhar, K.R. 2021. "Virtual Care: Choosing the Right Tool, at the Right Time." *Ann Fam Med* 19:365-367. https://doi.org/10.1370/afm.2693.

Taylor, P., C. Berg, J. Thompson, K. Dean, T. Yuan, S. Nallamshetty, and I. Tong. 2022. "Effective Access to Care in a Crisis Period: Hypertension Control During the COVID-19 Pandemic by Telemedicine." *Mayo Clin Proc Inn Qual Out.* 6, no. 1:19-26. https://doi.org/10.1016/j.mayocpiqo.2021.11.006.

Thomson, A.J., C.B. Chapman, H. Lang, A.N. Sosin, and K.M. Curtis. 2021. "Outpatient Virtual Visits and the 'Right' Amount of Telehealth Going Forward." *Telemedicine and eHealth* 27, no. 12:1372-1378. https://doi.org/10.1089/tmj.2020.0468.

Thomson, M.D., A.C. Mariani, A.R. Williams, A.L. Sutton, and V.B. Sheppard. 2021. "Factors Associated With Use of and Satisfaction With Telehealth by Adults in Rural Virginia During the COVID-19 Pandemic." *JAMA Network Open* 4, no. 8:e2119530. doi:10.1001/jamanetworkopen.2021.19530.

Truong, M, L. Yeganeh, O. Cook, K. Crawford, P. Wong, and J. Allen. 2022. "Using Telehealth Consultations for Healthcare Provision to Patients From Non-Indigenous Racial/Ethnic Minorities: a Systematic Review." *J Am Med Inform Assoc.*; epub. https://doi: 10.1093/jamia/ocac015.

Tuckson, R.V., M. Edmunds, and M.L. Hodgkins. 2017. "Telehealth." *N Engl J Med* 377:1585-1592. https://doi:10.1056/NEJMsr1503323.

Uhl, S., A. Bloschichak, A. Moran, K. McShea, M. Nunemaker, J.R. McKay, and K.E. D'Anci. 2022. "Telehealth for Substance Use Disorders: A Rapid Review for the 2021 U.S. Department of Veterans Affairs and U.S. Department of Defense Guidelines for Management of Substance Use Disorders." *Ann Int Med.* https://doi.org/10.7326/M21-3931.

United Health Group. 2019. "18 Million Avoidable Hospital Emergency Department Visits Add $32 Billion in Costs to the Health Care System Each Year." July 2019. https://www.unitedhealthgroup.com/content/dam/UHG/PDF/2019/UHG-Avoidable-ED-Visits.pdf.

UnitedHealthGroup. "Dental Care Goes Virtual." April 7, 2022. https://weeklydose.uhg.com/episodes/dental-care-goes-virtual.

Uscher-Pines, L., J. Sousa, M. Jones, C. Whaley, C. Perrone, C. McCullough, and A.J. Ober. 2021. "Telehealth Use Among Safety-Net Organizations in California During the COVID-19 Pandemic." *JAMA* 325, no. 11:1106-1107.

Uscher-Pines, L., N. Arora, M. Jones, A. Lee, J.L. Sousa, C.M. McCullough, S. Lee, et al. 2022. "Experiences of Health Centers in Implementing Telehealth Visits for Underserved Patients During the COVID-19 Pandemic: Results From the Connected Care Accelerator Initiative." Rand Corporation. https://www.rand.org/pubs/research_reports/RRA1840-1.html.

Vaidya, A. 2022a. "New Bill Aims to Make Telehealth an Excepted Employee Benefit." mHealthintelligence, April 2, 2022. https://mhealthintelligence.com/news/new-bill-aims-to-make-telehealth-an-excepted-employee-benefit.

———. 2022b. “New Senate Bill Aims to Extend Medicare Telehealth Waivers By 2 Years.” mHealthIntelligence, February 10, 2022. https://mhealthintelligence.com/news/new-senate-bill-aims-to-extend-medicare-telehealth-waivers-by-2-years.

———. 2022c. “4 States Advance Telehealth Bills.” mHealthIntelligence, April 8,2022. https://mhealthintelligence.com/news/4-states-advance-telehealth-bills.

———. 2022d. “Telehealth Snapshot: Use Cases, Policies & Hybrid Care.” mHealth Intelligence, April 7, 2022. https://mhealthintelligence.com/features/telehealth-snapshot-use-cases-policies-hybrid-care

Vogt, E.L., B.M. Welch, B.E. Bunnell, J.F. Barrera, S.R. Paige, M. Owens, P. Coffey, N. Diazgranados, and D. Goldman. 2022. “Quantifying the Impact of COVID-19 on Telemedicine Utilization: Retrospective Observational Study.” *Interact J Med Res* 11, no. 1:e29880. https://doi:10.2196/29880.

Volcy, J., W. Smith, K. Mills, A. Peterson, I. Kene-Ewulu, M. McNair, R. Kelsey, and N. Mbaezue. 2021. “Assessment of Patient and Provider Satisfaction With the Change to Telehealth From In-Person Visits at an Academic Safety Net Institution During the COVID-19 Pandemic.” *J Am Board Fam Med* 34:S71-S76. https://doi:10.3122/jabfm.2021.S1.200393.

Vosburg, R.W., and K.A. Robinson. 2022. “Telemedicine in Primary Care During the COVID-19 Pandemic: Provider and Patient Satisfaction Examined.” *Telemedicine and e-Health* 28, no. 2:167-175. http://doi.org/10.1089/tmj.2021.0174.

Wahezi, S.E., L.R. Kohan, B. Spektor, S. Brancolini, T. Emerick, J.M. Fronterhouse, M.M. Luedi, et al. 2021. “Telemedicine and Current Clinical Practice Trends in the COVID-19 Pandemic.” *Best Practice & Research Clinical Anaesthesiology* 35, no. 3:307-319. https://doi.org/10.1016/j.bpa.2020.11.005.

Wicklund, E. 2021. “New Bill Targets Telehealth Provisions in High-Deductible Health Plans.” mHealthIntelligence, October 25, 2021. https://mhealthintelligence.com/news/new-bill-targets-telehealth-provisions-in-high-deductible-health-plans.

Williams, D. Jr., A.N. Simpson, K. King, R.D. Kruis, D.W. Ford, S.A. Sterling, A. Castillo, C.O. Robinson, K.N. Simpson, and R.L. Summers. 2021. “Do Hospitals Providing Telehealth in Emergency Departments Have Lower Emergency Department Costs?” *Telemedicine and e-Health* 27, no. 9:1011-1020. http://doi.org/10.1089/tmj.2020.0349.

Xu, H., B.B. Granger, C.D. Drake, E.D. Peterson, M.E. Dupre. 2022. “Effectiveness of Telemedicine Visits in Reducing 30-Day Readmissions Among Patients With Heart Failure During the COVID-19 Pandemic.” *Journal of the American Heart Association* 11, no. 7:e023935.

Xu, S., S. Glenn, L. Sy, L. Qian, V. Hong, D.S. Ryan, and S. Jacobsen. 2021. “Impact of the COVID-19 Pandemic on Health Care Utilization in a Large Integrated Health Care System: Retrospective Cohort Study.” *J Med Internet Res* 23, no. 4:e26558. https://doi:10.2196/26558.

Yatabe, J., M.S. Yatabe, R. Okada, and A. Ichihara. 2021. “Efficacy of Telemedicine in Hypertension Care Through Home Blood Pressure Monitoring and Videoconferencing: Randomized Controlled Trial.” *JMIR Cardio* 5, no. 2:e27347. https://doi:10.2196/27347.

Yilmaz, S.K., B.P. Horn, C. Fore, and C.A. Bonham. 2019. "An Economic Cost Analysis of an Expanding, Multi-state Behavioural Telehealth Intervention." *Journal of Telemedicine and Telecare* 25, no. 6:353-364. https://doi.org/10.1177/1357633X18774181.

Zhao, L., J. Chen, L. Lan, N. Deng, Y. Liao, L. Yue, I. Chen, S.W. Wen, and R.H. Xie. 2021. "Effectiveness of Telehealth Interventions for Women With Postpartum Depression: Systematic Review and Meta-analysis." *JMIR Mhealth Uhealth* 9, no. 10:e32544. https://doi:10.2196/32544.

About The Society of Actuaries Research Institute

Serving as the research arm of the Society of Actuaries (SOA), the SOA Research Institute provides objective, data-driven research bringing together tried-and-true practices and future-focused approaches to address societal challenges and your business needs. The Institute provides trusted knowledge, extensive experience and new technologies to help effectively identify, predict and manage risks.

Representing the thousands of actuaries who help conduct critical research, the SOA Research Institute provides clarity and solutions on risks and societal challenges. The Institute connects actuaries, academics, employers, the insurance industry, regulators, research partners, foundations and research institutions, sponsors and nongovernmental organizations, building an effective network that provides support, knowledge and expertise regarding the management of risk to benefit the industry and the public.

Managed by experienced actuaries and research experts from a broad range of industries, the SOA Research Institute creates, funds, develops and distributes research to elevate actuaries as leaders in measuring and managing risk. These efforts include studies, essay collections, webcasts, research papers, survey reports, and original research on topics impacting society.

Harnessing its peer-reviewed research, leading-edge technologies, new data tools and innovative practices, the Institute seeks to understand the underlying causes of risk and the possible outcomes. The Institute develops objective research spanning a variety of topics with its strategic research programs: aging and retirement; actuarial innovation and technology; mortality and longevity; diversity, equity and inclusion; health care cost trends; and catastrophe and climate risk. The Institute has a large volume of topical research available, including an expanding collection of international and market-specific research, experience studies, models and timely research.

Society of Actuaries Research Institute
475 N. Martingale Road, Suite 600
Schaumburg, Illinois 60173
www.SOA.org